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A

MONOGRAPH

OF

THE FRESH-WATER POLYZOA,

INCLUDING

ALL THE KNOWN SPECIES,

BOTH BRITISH AND FOREIGN.

BY

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TO

THE REV. THOMAS ROMNEY ROBINSON,

D.D., M.R.I.A., F.R.A.S.,

FROM WHOSE PROFOUND KNOWLEDGE OF THE LAWS OF THE INORGANIC WORLD,

THOSE OF THE ORGANIC

HAVE ALWAYS RECEIVED FELICITOUS ILLUSTRATION AND ELOQUENT EXPOSITION,

The following Pages are inscribed,

IN MEMORY OF THE HOURS PASSED UNDER HIS PRESIDENCY AT THE MEETINGS OF
THE ROYAL IRISH ACADEMY,

IN RECOGNITION OF A MUCH-VALUED FRIENDSHIP,

AND IN ADMIRATION OF A MIND RICHLY STORED WITH TRUTH,

TO WHICH

EVERY DEPARTMENT OF KNOWLEDGE HAS FREELY AND ABUNDANTLY CONTRIBUTED.

Edinburgh, May 6, 1857

PREFACE.

The following work contains the result of many years' careful study of the fresh-water representatives of a group of animals which, in all their relations, are full of interest for the philosophic naturalist.

The highly curious modification of the Molluscan type which the Polyzoa present, their singular repetition in this type of the physiognomical features and habits of a totally different one, the great beauty of their forms, and the facility with which they can in general be observed in a living state, cannot but render them special favorites for every lover of Nature, and for the more profound student must confer on them a peculiar significance, and invest their study with a scientific interest which is scarcely surpassed by that of any other group of animals; while the fresh-water species, by certain remarkable peculiarities of structure, throw an unexpected light on the general plan and affinities of the class.

In the preparation of the monograph no trouble has been spared to render it as complete as possible, and the subjects of which it treats have been considered under every point of view of which they seemed susceptible—zoographically, zootomically, homologically, and historically. Nearly every species has been carefully examined in a recent state, while the anatomical observations have been over and over again repeated for the purpose of verification, and many hundred specimens have thus passed beneath the dissecting needle.

Of all the known fresh-water genera there are but two, namely, *Pectinatella* and *Urnatella*, which I have not yet had an opportunity of examining in a living condition. Both these genera, each consisting of a single species, are confined to the United States of America, where they were recently discovered by Dr. Leidy, who has given us a description of them, which, however, is purely zoographical. To Dr. Leidy's promised anatomical account of *Urnatella*, we cannot but look forward with impatience, while, in the mean time, I have had a woodcut prepared from a pencil sketch kindly furnished me by Dr. Leidy, so that I am enabled to introduce into the present work, a figure representing some of the more important features in the structure of this remarkable Polyzoon.

All the figures upon the eleven lithographic plates which accompany this volume have been drawn from Nature, and contain careful representations of every species which I have seen. They have been engraved by Mr. Tuffen West, who has spared no pains in rendering the original drawings as faithfully as possible. In every case I have given a figure of the species both in its natural size, and magnified, and I have never omitted to draw the polypide as well as the cœnœcium, believing that the latter will by itself convey but a very imperfect idea of the real character of these beautiful little animals. With regard to the few species which I have not had an opportunity of personally examining, I have availed myself of the existence of published drawings whenever they were to be found, and under the description of these species have given a woodcut copy of the drawing. The zoographical portion of the volume has thus been rendered as complete as possible for the practical identification of the species.

In fixing the exact limits of the species, some difficulty has been experienced. I have however, deemed it best to describe as a distinct species every well-marked variation of form which I could not find connected by intermediate gradations with other forms, and which could not, with probability, be referred to the accidental influence of external agencies. It is possible that some of the forms here described as distinct species may afterwards prove to be only varieties of one and the same specific group; but as they all possess a real existence, and are truly distinct forms, it was thought necessary, especially in so small a group as the present, to bring them definitely before the student, even though the future discovery of intermediate forms may disentitle them to a proper specific rank.

While the present work, in its purely zoographical relations, is entirely confined to those species which inhabit the fresh water, its anatomical details have a much more extended application. The Polyzoa constitute an exceedingly natural group, and possess great uniformity of structure, and as the fresh-water species afford fine typical examples of the class, a work devoted to the anatomy of these will apply in all essential points to that of the entire class, while such points of structure as are peculiar to the fresh-water forms will only tend to illustrate and explain the structure of the marine ones; so that the present monograph, in its anatomical relations, may be fairly regarded as a general treatise on polyzoal organization.

While the Fresh-water Polyzoa have been carefully studied on the Continent, especially by Van Beneden and Dumortier, they have hitherto (if we except an excellent paper by Mr. Albany Hancock) received in this country but little attention; and yet, even apart from its scientific interest, few departments of microscopic observation will be found to possess more attractiveness. There is scarcely a pond or canal of clear water where some of the species may not be found; most of them occur often in great abundance in the waters round London, and a slight acquaintance with their habits, as described in the present work, will render them very easy of detection; while few objects are capable of affording greater pleasure than these beautiful little molluscoids when examined in a living state under a moderate power of the microscope.

Notwithstanding the large proportion of species which will be found described and figured for the first time in this monograph, I have little doubt that the discovery of many more will reward a patient exploration of their habitats. I have endeavoured to render the work as practically useful as possible, and one of the advantages which I hope to see result from its publication will be the placing in the hands of the naturalist a manual which may facilitate further study of a group so full of interest, and among which I doubt not that many new facts still remain to be discovered.

To the many friends who, by the communication of specimens, and by much valuable information, have kindly assisted me in the preparation of this monograph, I beg once for all to return my best thanks. My acknowledgments are especially due to Mr. Bowerbank, Mr. Quekett, Mr. Busk, Mr. Albany Hancock, Mr. Huxley, Dr. Dickie of Belfast, Dr. Hassall of London, Mr. Wigham and Mr. Brightwell of Norwich, Professor Bailey of West Point, United States, and Dr. Leidy of Philadelphia.

To the Council of the Ray Society I must also express my grateful acknowledgments for the ready and obliging manner with which they have invariably complied with my requests, and for the patience with which they have submitted to the delay which has taken place in the publication. The work, indeed, ought to have been long since in the hands of the Society, but has been unavoidably delayed by the accession of new and largely increased professorial duties, which rendered it impossible for me to have it ready for the press so soon as I had hoped, and which must now plead my excuse for the lateness of its appearance.

MONOGRAPH

OF

THE FRESH-WATER POLYZOA.

Among the most beautiful and interesting forms of invertebrate animals are those strange phytoidal productions which, long confounded with the polypes, were at last, by the nearly simultaneous investigations of several naturalists, separated as a distinct group, and described by Thompson under the name of *Polyzoa*, and shortly after indicated by Ehrenberg under that of *Bryozoa*. They are chiefly inhabitants of the sea, where they may be witnessed under numerous plant-like guises; now spreading like a lichen over submerged stones, or old shells, or the broad fronds of Laminaria and other sea-weeds; now forming soft, irregular, fungus-like masses, or hard, calcareous, branchy growths, like diminutive trees; and now again presenting the appearance of the most delicate and exquisitely formed sea-weed or moss, offering, even to the unassisted eye, in the endless repetition of the same element of form, objects of surpassing symmetry and beauty.

The Polyzoa, however, are not by any means exclusively confined to the ocean; and though by far the greater number are marine, yet in the still and running waters of the land—in the broad river and the rushing stream—in the pure, cold mountain lake and the stagnant waters of the moory fen, species are to be found, which in interest yield not one jot to their brethren of the sea, and offer to the naturalist an inexhaustible source of gratification, in the beauty of their forms and the wonders of their organization.

It is to these fresh-water species, which, independently of their peculiar habitat, possess certain characters entitling them to be viewed as a group apart from the marine representatives of the class, that the present work is to be devoted. It will be well, however, before entering into the detailed treatment of our subject, to take a general historical view of the facts which led to the establishment of the Polyzoa as a distinct class of the animal kingdom. These facts are so intimately mixed up with the gradual development of correct views as to the nature of the true Polypes, with which the Polyzoa had, until recent times, been confounded, without any suspicion of the wide interval by which they were really separated, that their historical statement will necessarily involve a rapid glance at the progressive steps made by the earlier naturalists in the determination of the animality of corals.

Historical view of the facts which finally led to the establishment of the Polyzoa as a distinct class.

It was in the last year of the sixteenth century that the Neapolitan, Ferante Imperato, asserted that corals possessed the nature of animals.[*] The announcement had passed away nearly unheeded; and if at the end of more than a hundred years afterwards any lingering doubts as to the vegetability of these productions still remained, it was deemed that the discovery of the Count de Marsigli, who, in the year 1706,[†] declared that he had seen coral in flower, must have totally dissipated them.

Not so, however, thought Jean André Peyssonelle, physician at Marseilles; he soon saw that the flowers described by Marsigli were nothing more than the beautiful starry polypes of the coral, and he maintained that these were true animals of the same nature as the Actiniæ of the rocks, whose animality was sufficiently obvious to leave no room for doubt, and that the hard stony coral was a peculiar habitation built by these creatures for their protection.

But Peyssonelle had few followers; even Reaumur, to whom he had intrusted a communication on this subject, with the intention of having it presented to the Academy of Science at Paris, not only strongly opposed the views of Peyssonelle, while laying them before the Academy, but, through consideration for the reputation of the author, deemed it right to suppress his name in connection with so absurd and visionary a doctrine.[‡]

Among those, however, who saw something more than the mere dreams of a visionary in the doctrines of Peyssonelle, was the celebrated botanist, Bernard de Jussieu. He felt their importance; and, in 1741, he visited the coast of Normandy, in order to subject them to the test of actual observation. De Jussieu had here an opportunity of examining the Alcyoniums, Sertulariæ, Flustræ, and other flexible and plant-like productions to which the observations of Peyssonelle had not extended, and the result was a complete conviction of their animality, and a firm adherence to the doctrines of Peyssonelle.

In communicating to the Royal Academy of Sciences[§] the result of his observations, B. de Jussieu employed the word *polype* to designate the various productions whose animal nature had thus been so satisfactorily determined, a term which up to the present day has been in general adoption.

It was just at this time that Abraham Trembley was engaged in his famous experiments on the Hydra, which Leeuwenhoek had originally discovered, attached to the leaves of Lemna, along with various fresh-water Infusoria; and of which he had in 1703 communicated a notice to the Royal Society of London.[‖]

The close relation of the Hydra with the marine polypes was now abundantly apparent, and the important light which its study shed upon the nature of these polypes, has invested its discovery with a peculiar interest as marking out a distinct epoch in the progress of zoology.

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[*] Feranta Imperato, 'Historia Naturale,' Napoli, 1599.

[†] In a letter to the Abbé Bignon. See Marsigli, 'Brieve ristretto del Sagio fisico intorno alla Storia del Mare,' Venezia, 1711.

[‡] 'Mém. de l'Acad.,' 1727. [§] 'Mém. de l'Acad.,' 1742. [‖] 'Phil. Trans.,' 1703.

The celebrity conferred on Trembley by his researches into the structure and economy of Hydra, is known to every one in the least acquainted with the literature of zoology; but the assiduity of the famous historian of the fresh-water polype was destined to be rewarded by a discovery perhaps just as important as that of the economy of Hydra. It was in the month of April, 1741, that Trembley, while engaged in his researches on Hydra, discovered, in the fresh waters near the Hague, an animal form then quite new to science. It consisted of a lobed jelly-like mass, from which protruded numerous polypoid bodies, each characterised by the possession of an elegant crown of tentacula borne on the margin of a crescent-shaped disc. This beautiful tentacular plume is one of its most striking features; and as Trembley naturally supposed his animal to be intimately related with the polypes, it suggested the name of "Polype à Panache," by which he subsequently designated it.[*]

Almost immediately after this the same species was detected in England by Baker, who subsequently described it under the name of "Bellflower animal."[†] Both Trembley and Baker bestowed upon their new animal a careful and accurate examination, and have thus made us acquainted with a very remarkable type of structure—a type, however, whose significance was destined to remain for nearly a century unrecognised, and it was not until a similar one in certain marine polypoid animals arrested the attention of naturalists, that its importance, and its true bearing on systematic zoology, began to be appreciated. The investigations of Trembley and Baker, however, having clearly demonstrated, in the "Polype à Panache," all the essential characters of polyzoal structure, must be viewed as marking out another most important epoch in the progress of zoological research.

Among the converts which the discoveries of Trembley and Jussieu had made to the animal theory of corals, was Reaumur, who, convinced by their reasoning, withdrew the opposition with which he had met the announcement of Peysonelle, and now ranged himself among the most strenuous supporters of the new doctrine.[‡] Still, however, assent was far from universal, and the greater number of naturalists continued to believe in the vegetability of corals, and denounced the new opinions as false and absurd. Even the celebrated Linnæus, though he admitted the animality of the stony corals, or lithophytes as he termed them, could never bring himself to express unqualified belief in the animality of those horny and flexible forms which embraced the Tubularidæ, Sertularidæ, Gorgoniæ, &c., and most of the Polyzoa of modern zoologists; and accordingly he took a sort of middle ground, maintaining that these productions possessed a double nature, that their stems and branches grew by a true vegetation and possessed the essential characters of plants, while their polypes were certain inflorescences or developments of the vegetable axis in which the vitality had become exalted from the vegetable into the animal.

Even this partial admission by Linnæus of the flexible corals and Polyzoa into the animal kingdom was due to the discoveries of John Ellis, a London merchant, who, amid the engrossing cares of his counting-house, could yet throw open his heart to the love of Nature, and find time for the cultivation of science. In the year 1752 Ellis presented to the Royal Society the result of his first observations on the nature of these creatures. He seems to have then known but little of the labours of his predecessors in the same field, and his researches, which were thus entirely independent, led him to the conclusion, "that these apparent plants were ramified animals in their proper skins or cases." In 1755, he published his famous 'Essay on the Natural History of Corallines,'[*] a work which in profuseness and fidelity of observation, in lucidity of description, and in pictorial illustration, seemed to leave little else to be accomplished.

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[*] 'Mémoires pour servir à l'Histoire d'un Genre de Polypes d'Eau douce,' Leide, 1744, Mém. III.

[†] 'Employment for the Microscope,' London, 1753.

[‡] 'Mémoires pour servir à l'Histoire des Insectes,' Paris, 1742, tome vi, Preface.

Linnæus, who, as we have just seen, met the animal theory only half way, was never entirely convinced; he continued, too, for some time, to have his followers, but Ellis had sapped the very foundations of the vegetable theory, and in a few years, notwithstanding bitter opposition from some isolated quarters, the question was finally set at rest in the general admission of the animality, not only of the true corals and madrepores, but of all those flexible and horny productions whose plant-like form was at such variance with every previously conceived notion of animal existence.

It was not yet suspected that among these curious "zoophytes," so like one another in external form, there were still two totally distinct types of animal organization; and the attention of naturalists was now chiefly directed to the comparison of external characters for the determination of species, and as the grounds of classification. Numerous systems were accordingly from time to time proposed, which, however, were all more or less artificial, and involved the fundamental error of assuming the external calcareous or horny covering as a character of primary importance, and, as a necessary consequence, the association of forms of a widely different plan of structure.

In the mean time the number of known species had greatly increased, and collections, both on our own and foreign shores, had enriched this department of natural history to an extent of which few others could boast. Important improvements too had taken place in our means of observation, and the value of anatomy in the determination of the true rank of organic beings had been very generally recognised. Zoologists were thus prepared to appreciate the importance of the new light which was about to be thrown upon the structure of these plant-like productions.

In March, 1827, Professor Grant read before the Wernerian Society a Memoir on the structure of Flustræ.[†] In this Memoir the author has described the locomotive embryos of Flustræ; he also gives an account of the animals of *Flustra carbasea* and *F. foliacea*, and shews them to be quite different from the hydroid polype of the Sertulariæ; but he seems as yet to have had but an imperfect knowledge of them, and I cannot find anything in the Memoir to justify the belief that this excellent zoologist was acquainted with the complete intestinal canal of the animal.

In September of the following year MM. Auduin and Milne-Edwards presented to the Royal Academy of Sciences, in Paris, a summary of their researches on the invertebrate animals of the Chausey Isles, a group of small rocky islands off the coast of France. Among these researches the investigations of M. Edwards into the Flustræ hold a prominent place. No one could have come better prepared for the task than the celebrated French zoologist. Already long devoted to the study of the invertebrate animals, and just fresh from a series of most valuable investigations into the Compound Ascidiæ, M. Edwards, without any knowledge of the labours of Grant in the same field, not only demonstrated in a very complete manner the anatomy of the Flustræ, but was the first to call attention to the close connection of their structure with that of the Ascidiæ, and the important bearing of this connection on their systematic rank.* Cuvier had already determined a striking difference of structure between the Sertularian Polypes and those of Alcyonium, and a third type of structure, widely different from both, was now pointed out by M. Edwards as characterising the Flustræ and their allies, which he proposed to distinguish under the name of "Polypes tuniciens."

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[*] 'Essay towards a Natural History of the Corallines and other Marine productions of the like kind, commonly found on the Coasts of Great Britain and Ireland,' London, 1755.

[†] Observations on the Structure and Nature of Flustræ, 'Edinb. New Philosophical Journal,' vol. iii, 1827.

At the same time that the British and French zoologists were engaged in these interesting discoveries, an accomplished and philosophic naturalist, Mr. J. V. Thompson, then officially stationed at Cork as deputy-inspector-general of hospitals, was making a series of observations on the marine productions of the coast. These observations had been commenced several years before, and had already resulted in the celebrated discovery of the metamorphosis of the Crustacea; it was not, however, until December, 1830, that they were given to the public. In this year the author published the first number of a projected periodical† which was to contain a series of original memoirs on zoological subjects. Among the many important papers contained in this publication was one "On Polyzoa, a new animal discovered as an inhabitant of some Zoophytes."

Thompson had examined the animals of *Bowerbankia imbricata*, *Valkeria cuscuta*, *V. pustulosa*, *Vesicularia spinosa*, and other allied forms, and the difference of their structure from that of the Sertulariæ, with which they had been hitherto classed, struck him in its full force. He traced the entire course of the alimentary canal, and made himself master of almost every important point in their structure. He also perceived their close relation to the compound Ascidiæ, and was the first to designate them by a distinct name which no longer assumed their connection with the polypes. The name thus proposed by Thompson for the group whose structure he had so well investigated was "Polyzoa."

Residing in a remote part of Ireland, and in a great measure cut off from intercourse with scientific men, Thompson was quite unaware, when he published the result of his researches, that Grant and Edwards had been before him in the field; his observations are, therefore, original and independent, and, as he tells us they were made in the summer of 1820, it would seem that it was only the delay of publication that has deprived him of the honour of being the first to record a discovery so important in the history of zoology.

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* Dumortier and Van Beneden ('Hist. Nat. des Pol. comp. d'eau douce') assign to Lamouroux the merit of having been the first to detect the affinity between the Polyzoa and the Ascidiæ. Lamouroux's views, however, upon this point are exceedingly vague and incorrect; the difference between the Polyzoa and the true radiate zoophytes never occurred to him, and he imagines the affinity with the Mollusca to be possessed by the entire group of his polypes à polypiers. "J'ai dit," says he ('Exposition Méthodique des Genres de l'Ordre des Polypiers', Preface, p. vii), "que les polypes à polypiers ne pouvaient en aucune manière se comparer aux Hydres d'eaux douce, sous le rapport de l'organisation; qu'ils étaient plus voisins qu'on ne le pensait de la nombreuse famille des Mollusques, et qu'avec le temps on en ferait peut-être une division de cette grande classe. Les nouvelles observations que les circonstances m'ont permis de faire me confirment dans cette idée, et je ne doute plus que les animaux des polypiers ne soient des êtres aussi compliqués dans leur organisation que les Mollusques Ascidiens." He then goes on to compare the walls of the body cavity in *Gorgonia*, *Isis*, *Alcyonium*, &c., to the tunics of an Ascidian or the mantle of an ordinary Mollusc, a comparison which plainly shows that he had no idea whatever of the relation in question.

† 'Zoological Researches and Illustrations.' By John V. Thompson. Cork, 1830. The date is not printed on the title-page; but is to be found on the paper wrapper in which the publication was originally stitched.

In 1834 Ehrenberg published his 'Memoir on the Corals of the Red Sea.'* In this work he proposed a new classification of the so-called polypes, dividing the entire group into two great sections—the *Anthozoa* and the *Bryozoa*: the former embraced the true radiate forms, the latter corresponded to the Polyzoa of Thompson. Though the term Bryozoa had already been used by him in a number of the 'Symbolæ Physicæ,' published in June, 1831, the priority of publication is still left with Thompson's name, and though Ehrenberg's term is in general use upon the Continent, and is largely adopted even by English writers, simple justice and the laws of natural-history nomenclature demand the adoption of the term *Polyzoa*, and it is it, therefore, which I have employed in the present Memoir.†

Notwithstanding, however, the completeness with which the ascidian type of structure had now been recognised in the Polyzoa, naturalists had not yet emancipated themselves from the old notion that the closest affinities of these animals were still with the Polypes, and the Polyzoa, therefore, long continued to be classed with the Polypes, of which they were still considered as a group, though with distinct peculiarities, through which the Polypes manifested an affinity with the Tunicata.

It is not easy to say to whom we are indebted for the first absolute withdrawal of the Polyzoa from the Radiate sub-kingdom, and their location among the Mollusca. The obvious justice of the step must have simultaneously presented itself to every naturalist who had made the matter a special subject of study, while the important division of the Molluscan sub-kingdom by Milne Edwards into the two primary sections of the *Mollusca* and the *Molluscoida*, the latter including the Tunicata and the Polyzoa, leaves nothing now to be desired in the systematic location of the Polyzoa.

In the history of progressive discovery which has thus been sketched, eight distinct epochs must be noted, each characterised by some one step which has more or less directly led to the views at present entertained of the true affinities and systematic position of the Polyzoa. 1. The assertion by Imperato of the *animality* of coral. 2. The discovery by Marsigli of the *polypes* of coral, which he mistook for its flowers. 3. The determination of the true nature of these polypes by Peysonelle. 4. The discovery of the *Hydra* by Leuwenhoeck. 5. The discovery of the "Polype à Panache," and the determination of its structure by Trembley and Baker. 6. The determination of the structure of certain marine Polyzoa by the independent and nearly simultaneous labours of Grant, Edwards, and Thompson; and the recognition of the affinity of these productions with the compound Ascidians by Edwards and Thompson. 7. The designation, by a common independent name, of these animals by Thompson. 8. The entire withdrawal of the Polyzoa from the Radiata and their association with the Mollusca.

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* 'Beiträge zur physiologischen kenntniss der Corallen-thiere im algemeinen, und besonders des Rothen Meeres.'

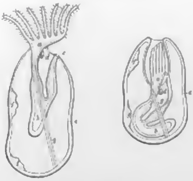
† See an admirable criticism by Busk on the Priority of the term Polyzoa, in the 'Annals of Nat. Hist.,' vol. x. 1852.

ANATOMY AND PHYSIOLOGY.

I.

PRELIMINARY MATTER

General conception of a Polyzoon.



PLAN OF A POLYZOON.

Fig. 1. Erected Fig. 2 Retracted.

a. Region of mouth, surrounded by tentacula. b. Alimentary canal. c. Anus. d. Nervous ganglion. e. Membranous investing sac. f. Testis. f′ Ovary. g Retractor muscle.

Let us imagine an alimentary canal, consisting of œsophagus, stomach, and intestine, to be furnished at its origin with long ciliated tentacula, and to have a single nervous ganglion situated on one side of the œsophagus. Let us now suppose this canal to be bent back upon itself towards the side of the ganglion so as to approximate the termination to the origin. Further, let us imagine the digestive tube thus constituted to be suspended in a fluid contained in a membranous sac with two openings, one for the mouth and the other for the vent, the tentacula alone being external to the sac. Let us still further suppose the alimentary tube, by means of a system of muscles, to admit of being retracted or protruded according to the will of the animal, the retraction being accompanied by an invagination of the sac so as partially or entirely to include the oral tentacula within it; and if to these characters we add the presence of true sexual organs in the form of ovary and testis occupying some portion of the interior of the sac, and the negative character of the absence of all vestige of a heart, we shall have perhaps as correct an idea — apart from all theoretical considerations of homology or derivation from an archetype—as can be conveyed of the essential structure of a Polyzoon in its simplest and most generalised condition.

To give, however, more actuality to our ideal Polyzoon, we may bear in mind that the immediately investing sac has the power, in almost every case, of secreting from its external surface a secondary investment of very various constitution in the different groups; and we may, moreover, conceive of the entire animal with its digestive tube, tentacula, ganglion, muscles, generative organs, circumambient fluid, and investing sacs, repeating itself by gemmation, and thus producing one or more precisely similar systems holding a definite position relatively to one another, while all continue organically united, and we shall then have the actual condition presented by the Polyzoa in their fully developed state.

Definition of Terms.

The old notion, which, by mistaking the zoological rank of the Polyzoa, erroneously referred them to the class of the Polypes, caused the same terms to be applied to them which were also used to designate the various parts of the true Polypes. The recognition, however, of a type of structure in the Polyzoa totally distinct from that of the Polypes proper, necessitates a change in the terminology employed in their description. On these grounds I have ventured to substitute some new terms for those previously used, while our increased knowledge of polyzoal structure necessitates the use of certain additional terms of which we have no representatives in the descriptive terminology of previous authors. For the term Polype, therefore, originally applied not only to the polypoid Radiata, to which its use ought to be confined, but also to the retractile portion of the Polyzoa, I have substituted in the following memoir that of *Polypide*.* To the common dermal system of a colony, which, as well as the solid basis of the true polypes, was formerly known under the names of Polypery and Polypidome, I have applied the term *Cœnœcium*.† The cœnœcium is composed almost universally of two perfectly distinct tunics; to the external I have given the name of *Ectocyst*,‡ and to the internal that of *Endocyst*.§ The sort of disc or stage which surrounds the mouth and bears the tentacula, I have called *Lophophore*.‖ The *Epistome*¶ is a peculiar valve-like organ which arches over the mouth in most of the fresh-water genera. The *Perigastric*** *space* is the space included between the walls of the endocyst and the alimentary canal.

The terms now enumerated are such as I believe the nature of the subject strictly requires. I employed most of them in my 'Report on Fresh-water Polyzoa' published in 1850, and though I am fully aware that the changing of an established terminology is highly objectionable where it can possibly be avoided, yet in the present case, where new facts have been accumulated requiring new words for their expression, and where the very same terms have been in two different classes of animals loosely applied to organs in no respect homologous, the purposes of a rigidly scientific description can, I believe, only be served by some such change as that suggested.

Besides these terms, and some which will be explained as they occur, two others in common use ought to be here defined. The *cells* are the little chambers of which the cœnœcium is made up, and in each of which a polypide is lodged. The part of the cell through which the polypide admits of protrusion and retraction is the *orifice* of the cell.

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* Πολύπους, εἶδος. † Κοινός, οἰκίον. ‡ Ἐκτος, κύστις. § Ἐνδον, κύστις. ‖ Λόφος, φορέω. ¶ Ἐπι, στομα. ** Περί, γαστήρ.

Determination of Aspects.

Another important point, which should be settled at the very outset of our anatomical inquiries, is the exact sense in which we are to use the terms employed to indicate the different *aspects* of a Polyzoon. This is the more necessary as the terms used for this purpose, in the description of the invertebrate animals generally, are frequently employed in the vaguest possible way, the same term being often applied by different authors to very different aspects of the animal.

In fixing the meaning of the terms *anterior* and *posterior* we may assume the position of the mouth as indicating the region of the animal which is to be designated as anterior, while the posterior region will then be that diametrically opposite.

In fixing the *dorsal* and *ventral* regions greater difficulty is met with. Mr. Huxley, in his very ingenious and philosophic Memoirs on the Homologies of the Mollusca,* rejects the terms dorsal and ventral altogether; generalising the Molluscan form under the conception of an ideal archetype, and finding the heart occupying one side, and the great nervous centres placed upon the opposite, he gives to the former region the name of "hæmal," and to the latter that of "neural," thus applying to the Mollusca the terms already so happily employed by Owen in his designation of the regions of the vertebrate skeleton.

These terms have the advantage of stating a simple fact, and of thus avoiding the ambiguity which so often attaches to the terms dorsal and ventral. I shall, therefore, willingly adopt them in the present Memoir, and notwithstanding an apparent contradiction in designating as "hæmal" any portion of an animal totally deprived of a blood-vascular system, I shall call that region of a Polyzoon on which the nervous ganglion lies the "neural," and the opposite region, that, namely, which corresponds to the part of an Ascidian which contains the heart, the "hæmal."

Tabular view of the Orders and Sub-orders of Polyzoa.

The reader will be further assisted in the anatomical inquiry in which we are now about to be engaged, by having placed before him here the following scheme of the orders and sub-orders under which all the species of Polyzoa, both marine and fresh-water, admit of being arranged:

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* 'English Cyclopædia,' 1855, article "Mollusca," and 'Phil. Trans.,' 1853.

Orders.		Sub-orders.
Lophophore bilateral; mouth with an epistome. PHYLACTOLÆMATA.*	Arms of lophophore free or obsolete.	Lophopea (fresh-water).
	Arms of lophophore united at the extremities.	Pedicellinea‡ (marine).
Lophophore orbicular, or nearly so; no epistome. GYMNOLÆMATA.†	Polypide only partially retractile?	Urnatellea§ (fresh-water).
	Polypide completely retractile; evagination of tentacular sheath imperfect.	Paludicellea (fresh-water).
	Polypide completely retractile; evagination perfect; orifice of cell destitute of moveable appendage	Cyclostomata (marine).
	Polypide completely retractile; evagination perfect; a circle of setæ attached to the invertible portion, and acting as an operculum in the retracted state.	Ctenostomata (marine).
	Polypide completely retractile; evagination perfect; orifice of the cell with a moveable lip.	Cheilostomata‖ (marine).

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* *Phylactolæmata* (from φυλάσσω, to guard, and λαιμὸς, the gullet, in allusion to the epistome placed at the entrance of the alimentary canal) corresponds in part with the *Hippocrepia* of Gervais. The Hippocrepia of the French zoologist, however, constitute in reality an artificial group. Being essentially characterised by the possession of a crescentic lophophore, they necessarily exclude not only *Pedicellina*, but even *Fredericella*, whose relations with the species furnished with a crescentic lophophore are of the most intimate kind. Hippocrepianism, therefore, though of great interest as a morphological fact, tending, as will be afterwards shown, to throw much light on certain homological questions, cannot be employed as the determining character of groups more comprehensive than those of generic rank

† *Gymnolæmata* (from γυμνὸς, naked, and λαιμὸς, in allusion to the absence of an epistome) corresponds to part of the *Infundibulata* of Gervais.

‡ For the structure of *Pedicellina*, see Note, p. 19.

§ The location of *Urnatella* among the Gymnolæmatous Polyzoa must for the present be viewed as a provisional expedient, subject to alteration as its structure becomes better known. See the description of the genus farther on.

‖ The terms *Cyclostomata*, *Ctenostomata*, and *Cheilostomata*, were proposed by Busk, to indicate the primary subdivisions of the marine Gymnolæmatous Polyzoa. (Voyage of "The Rattlesnake," vol. 1, Appendix, p. 346.)

2.

ANATOMY

A. *Organs for the Preservation of the Individual*

(1) *Dermal System*

Cœnœcium.—The Polyzoa being all composite animals, the cœnœcium constitutes essentially an assemblage of little cells or chambers, of very various form, organically connected with one another. Each chamber lodges a polypide, and its cavity is either shut off from those of the neighbouring chambers, or freely communicates with them. In every instance* the polypide can be protruded from its cell, and again withdrawn into it, and the part through which it thus passes outwards and inwards, as has already been defined, is the *orifice* of the cell. It must not, however, be supposed that there is here any proper orifice, the retraction and exsertion consisting merely in an invagination and evagination of the anterior part of the cell.

The cœnœcium, in every case, except in *Cristatella*, is composed of two distinct membranes, which must be carefully distinguished from one another—an internal, the *endocyst*, which is always soft, transparent, and contractile; and an external, the *ectocyst*, which varies greatly in character in the different genera.

The *endocyst* (Pl. III, fig. 7; V, figs. 5, 6; IX, fig. 7; X, fig. 4, *a*) lines the interior of the cells, and when it arrives at their apertures would protrude beyond the ectocyst were it not that it here becomes invaginated or inverted into itself, and then terminates by being attached round the base of the tentacular crown. During the exsertion of the polypide, the invaginated portion of the endocyst is carried out with the latter, thus undergoing a process of eversion, which, however, in all the fresh-water species, is but partial, a portion of the endocyst, as we shall afterwards more particularly see, remaining in a permanently inverted condition; in this respect differing remarkably from the marine species, in which the eversion of the endocyst is, perhaps, in all cases, if we except the anomalous genus *Pedicellina*, complete. The attachment of the endocyst to the base of the tentacular crown closes the cœnœcial chambers externally, while the polypide is thus suspended in the midst of the fluid with which these chambers are filled.

If we examine the endocyst *histologically*, we shall find that it possesses a very distinct structure. In *Lophopus*, which is particularly well adapted for observing the intimate structure of this membrane, we find it composed of large irregularly shaped cells, widely separated from each other by an intervening substance towards the posterior part of the cœnœcium, but more closely approximated towards the orifices. These cells are filled with a perfectly colourless and transparent fluid. Under the action of acetic acid each is distinctly seen to be bounded by a double outline, and to contain a large nucleus with nucleolus (Pl. II, fig. 9); the nucleus, with its nucleolus, are imbedded in the walls of the cell. The intervening substance, which, before the application of the acetic acid, appeared simply granular, is now seen to consist almost entirely of bodies exactly resembling the nuclei of the cells; some of these intercellular nuclei contain two nucleoli, and seem to be undergoing division, while round others a young cell may be seen in various stages of formation.

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* In *Pedicellina*, and apparently also in *Urnatella*, the power of protrusion and retraction is very imperfect, and is here limited to such change of position as is connected with a slight extension and flexion of the œsophagus.

These different stages may be satisfactorily followed, and afford a very interesting example of cytogenetic action. The first thing observed is the accumulation round the nucleus of a little mass of granular protoplasm. In the midst of this a minute vacuola next shows itself, this becomes the cell-cavity, and gradually increases in size with the enlarging cell; the nucleus is persistent, remaining attached to the cell-wall.

For reasons to be presently mentioned, it is highly probable that the endocyst is pervaded by a system of canals of extreme delicacy, which constitute an irregular network in its substance.

Besides the structure now described, peculiar fibres (Pl. II, fig. 10) are also developed in the endocyst. These are situated on its inner surface, where they constitute a well-marked layer composed of a network of transverse and longitudinal fibres over the whole extent of the endocyst. I have even succeeded in separating this network as a continuous layer.

There can be no doubt that these fibres of the endocyst are muscular, and that it is to their presence that the high degree of contractility enjoyed by the endocyst of *Lophopus* is in a great measure, if not entirely, due. When treated with acetic acid, they are plainly seen to be composed of greatly elongated fusiform cells, having their pointed extremities in connection with one another. Each of these cells is then also seen to contain a nucleus with nucleolus (Pl. II, figs. 11, 12).

We have seen that in all the fresh-water genera a portion of the endocyst remains in a permanently invaginated state. It is probable that in all these genera the endocyst retains its general structure and contractility for a greater or less extent of its permanently invaginated portion, down to a spot where the transverse fibres appear to become condensed into a sort of sphincter, and shortly after this the endocyst alters its texture, losing its contractility and becoming thinner (Pl. V, fig. 6). In this condition it continues till it terminates by being attached to the base of the tentacular crown. This thin, non-contractile portion of the endocyst constitutes the *tentacular sheath* which encloses and protects the tentacula during the retracted state of the polypide. Near the spot where the endocyst passes into the tentacular sheath, there appears to exist, at least in *Lophopus*, a circular canal, which here passes transversely round the endocyst. The presence of this canal is revealed by peculiar, spherical or oval, brilliant corpuscles, which it almost always contains in *Lophopus*.

A portion, perhaps the whole, of the inner surface of the endocyst is clothed with vibratile cilia.

Though I have not succeeded in making out the structure of the endocyst in the other genera so satisfactorily as in *Lophopus*, we may, nevertheless, conclude that it is nowhere very far different from that now described. In all these, fibres may be detected in the endocyst. In the species with bilateral lophophore, the fibres may be seen towards the apertures of the cells (Pl. V, figs. 5, 6, *e*); but it is generally impossible, in consequence of the increasing opacity of the superjacent structures, to trace these fibres to any distance posteriorly. In *Paludicella*, whose transparent ectocyst admits of a distinct view of all the contained parts, the fibres are collected into numerous transverse bands (Pl. X, figs. 3, 4, *e*), which we may trace throughout the whole extent of the cell.

A peculiar condition of the endocyst of *Lophopus*, though most probably only abnormal, must be mentioned here. In specimens of this Polyzoon which had been kept for a few days, and occasionally in some just captured, multitudes of minute oval brilliant corpuscles were seen to have been developed in the endocyst throughout its whole extent. They were not scattered at random through this membrane, but were contained in the interior of a system of tubes which formed a network in the substance of the endocyst (Pl. II, fig. 13). They are about the [illegible]th of an inch in the longer diameter, larger at one end than at the other, and in the large end they appear to contain a minute cavity (fig. 14), which under the action of acetic acid dilates and fills nearly the entire corpuscle (fig. 15). The situation of these bodies in a tubular network in the substance of the endocyst is a fact of great interest. It is nearly certain that whatever may have been the origin of the corpuscles, they found the tubes already existing for their reception. It would follow from this that the presence of a reticulated system of tubes in the substance of the endocyst is the normal condition of this tunic, but from the delicacy of these tubes, and the transparency and want of colour of their contents, they escape detection under ordinary circumstances, and are first revealed only by the abnormal (?) development of the peculiar corpuscles in their interior. These corpuscles are not confined to the endocyst, but are also found at the same time in other tissues, especially in the substance of the funiculus, which, as will be afterwards shown, connects the fundus of the stomach with the walls of the cells. In the endocyst alone, however, do they appear to be contained in distinct canals.

In *Cristatella*, where the endocyst constitutes the whole of the cœnœcium, it presents below a flattened disc, which closely resembles the foot of a gasteropodous mollusc, and on which this singular colony creeps about on the stems and leaves of aquatic plants, exposing its beautiful plumes to the light and warmth of the sun (Pl. I, fig. 2).

The *ectocyst* or external investment (Pl. III, fig. 7; V, figs. 5, 6; IX, fig. 7; X, fig. 4, *a*) is, in most of the species, composed of a tough pergamentaceous brown membrane, strengthened by the deposition of irregularly formed siliceous and other earthy particles, which, except towards the orifices, where these particles are deficient, give to the ectocyst an opacity which renders an observation of the contained parts a matter of considerable difficulty. In some species of *Plumatella*, and in *Alcyonella flabellum* and *A. Benedeni*, the earthy particles are entirely absent, from a longitudinal line which commences wide near the aperture of the cell, and gradually narrows as it passes backwards, when it soon assumes the appearance of a prominent keel, and then loses its transparency by the deposition of earthy matter, as in the rest of the ectocyst (Pl. VIII, figs. 2, 3). The perfectly transparent wide origin of this line gives to the orifice of the cell the appearance of having a deep notch on one side. In *Fredericella* a slightly prominent keel is also apparent, but the notch-like transparent space does not here exist.

In *Cristatella* (Pl. I) the ectocyst would seem to be entirely absent; and this genus, therefore, presents the anomalous condition of having the cœnœcium composed exclusively of the endocyst.*

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* This view of the cœnœcium of *Cristatella* is contrary to the opinion previously expressed by me; but I am now convinced that what I formerly described as the ectocyst of *Cristatella* is really its endocyst.

Lophopus, also, at first sight, conveys the impression of being destitute of an ectocyst, and having the place of this tunic supplied by a peculiar unorganized gelatinoid secretion, in which the colony is enveloped (Pl. II, figs. 2, 3). This gelatinous-looking investment is, however, a true ectocyst; it consists of a membranous tunic of great delicacy, apparently enclosing a perfectly transparent and colourless fluid, probably in the meshes of a sort of areolar tissue. I have not, however, succeeded in making out in it any distinct structure, but its membranous nature becomes at once manifest when the animal has undergone partial desiccation, for then the ectocyst is thrown into folds by losing a portion of the fluid which had been imprisoned in it. Neither Trembley nor Baker takes any notice of this gelatinoid envelope. M. Dumortier mentions it, and represents it in his figure,[*] while M. Van Beneden believes it to be an accidental investment acquired by the animal during confinement.[†]

The ectocyst in *Paludicella* is formed of a smooth pergamentaceous semi-transparent membrane, free from earthy deposit, and of a deep brown colour. Towards the orifice of the cell it becomes thin and delicate, and is here strengthened by four longitudinal horny ribs (Pl. X, fig. 3, *b''*). The part of the ectocyst to which the ribs are attached is carried inwards during extreme retraction of the polypide. These ribs I look upon as the true homologue of the *setæ* which crown the cell in *Bowerbankia* and other ctenostomatous Polyzoa; if these setæ were reduced in number to four, and instead of being free were attached along their entire length to the sides of the cell, they would at once be converted into the ribs of *Paludicella*; the fact of the setæ in the ctenostomatous Polyzoa being connected to one another by a delicate membrane does not in the least invalidate the view here taken, and the circumstance of their being detached from the sides of the cell in these Polyzoa will account for the different mode in which they are withdrawn during retraction.

In certain species of fresh-water Polyzoa, transverse septa exist between the cells. They are formed both by the ectocyst and endocyst. In *Paludicella* they acquire their maximum in development and constancy; they occur here between every cell, and consist of an annular process, which projects transversely from the ectocyst into the interior of the cell, with a covering of endocyst on its upper and under surface (Pl. X, fig. 4, *b'*). The septum thus formed is rendered complete by the aperture in its centre being closed by a peculiar body, which projects into the cavity of the cell at each side. The structure of this body is remarkable; it consists of a central mass, surrounded by a distinct layer of somewhat elongated cellules placed perpendicularly to its surface. The body which thus closes up the centre of the annular septum has, without doubt, some office to perform besides that of simply completing the septum; but upon the nature of this office, or the exact signification of the body itself, I can form no satisfactory opinion. In the other genera the septa are by no means so constant or complete as in *Paludicella*. In several species of *Plumatella*, especially *P. coralloides* (Pl. VII, figs. 2, 3), septa exist, but these generally occur only at intervals, leaving several cells between them, which communicate freely with one another: not unfrequently the septum itself is imperfect, admitting of a communication through its centre between two neighbouring cells. In *Alcyonella fungosa*, and in *Fredericella sultana*, imperfect septa may here and there be observed, while *Cristatella* and *Lophopus* would seem to be quite deprived of them, the cells in these genera all opening into one another.

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[*] Dumortier, Recherches sur l'Anat. et Physiol. des Polypes Comp. d'eau douce. 'Bul. de l'Acad. Roy. de Bruxelles,' 1835. Fig. reproduced in Dumortier and Beneden, Hist. Nat. des Pol. Comp. d'eau douce. 'Mém. de l'Acad. Roy. de Bruxelles,' 1848. Compl. t. xvi.

[†] Van Beneden, Recherches sur les Bryozoaires fluviatiles de Belgique. 'Mém. de l'Acad. Roy. de Belg.,' 1848.

The ectocyst of the fresh-water Polyzoa appears in every case to be absolutely structureless. The fact of cellulose being a constituent of the test of the Tunicata, induced me to look for it in the ectocyst of the Polyzoa, but I have never succeeded in obtaining satisfactory evidence of its existence in any of the tissues of the Polyzoa, either fresh-water or marine. I observed, however, that in one instance the ectocyst of *Plumatella repens*, after lying for several weeks in a concentrated solution of caustic potash, in which it had been first boiled, presented under the microscope, at one or two points, a distinctly blue tint on being wetted with tincture of iodine, and then with sulphuric acid, a fact which would seem to point to the possibility of the true cellulose reaction being only masked by the presence of other constituents, as we know to be the case in some of the tissues of plants which fail to strike a blue colour with iodine and sulphuric acid, until the removal, by a somewhat tedious process, of the adventitious matter. I do not, however, lay any stress on the blue colour produced in the above instance, as it did not occur in others, and was therefore probably accidental. Upon the whole, the reactions of the pergamentaceous ectocysts of *Plumatella*, &c., are rather in favour of this tissue being composed of *chitine*. It is quite insoluble in strong acetic acid, and in a concentrated solution of caustic potash, even when exposed to prolonged boiling in these fluids, or after month-long maceration in them: but it is soluble in concentrated nitric, hydrochloric, and sulphuric acid. Successive boiling in water, alcohol, ether, acetic acid, and caustic potash, renders it nearly colourless, without in any way altering its form, all which properties are among the essential characteristics of *chitine*, which would thus seem to replace in the ectocyst of the *Polyzoa* the cellulose of the test of the *Tunicata*, unless more elaborately conducted researches shall prove the essential constituent of the tissue in question be identical with the more highly nitrogenized *conchiolin* of ordinary Mollusca.*

(2.) *Organs of Digestion.*

The digestive system is very similar in all those species in which the lophophore is bilateral (*Phylactolæmata*); these we shall therefore consider together. *Paludicella*, which, with the exception of *Urnatella* (?), is the only fresh-water representative of the division with orbicular lophophore (*Gymnolæmata*), presents some peculiarities, and should be examined by itself.

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* See Schlossberger, Zur näheren Kenntniss der Muschelschalen, des Byssus und der Chitinfrage (Ann. der Chem. und Pharm. xcviii, 99.

a. Phylactolæmata.

The *mouth* (Pl. II, fig. 24, *d*) is a simple edentulous orifice of a circular or slightly crescentic form, placed in the centre of the body of the lophophore, and consequently occupying the bottom of the tentacular crater. Its margin is slightly elevated, and is continuous on the neural side, with a hollow valve-like organ (*e*) of very peculiar formation. This organ arches over the mouth, and may be aptly enough compared in shape to the epiglottis of certain mammifers. The cavity in its interior communicates through an opening (*e'*) in the lophophore with the perigastric space; the walls which are turned towards the mouth are thick, and densely clothed on their external surface with vibratile cilia, while those which look towards the vent are thin, membranous, and transparent, and destitute of cilia. It may be observed, when the polypide is exserted from its cell, to be in a constant motion, which consists in an alternate elevation and depression of the organ. The elevation is effected by distinct muscular fibres (*s*), which are visible through the transparent walls, and will be afterwards more particularly described, while the depression is probably the result of an antagonistic elasticity. I propose to designate this organ by the name of *epistome*. On its true function I am unable to throw any light; though it is here described in connection with the organs of digestion, its relation to the digestive system is perhaps very remote. It may possibly be more correctly viewed as connected with sensation. Its homological import will be afterwards considered.

From the mouth an *œsophagus* (Pl. II, fig. 24; V, fig. 5; IX, fig. 7, *f*) of considerable length leads downwards to the stomach; it becomes gradually narrower as it approaches the latter, into which it opens by a very distinct conical projection (Pl. III, fig. 7, *f'*).

To the œsophagus immediately succeeds the *stomach*, without the intervention of any distinct gizzard, such as we find in *Bowerbankia* and certain other marine Polyzoa; and I cannot explain the statement of so excellent an authority as Siebold, who asserts that he has seen in *Alcyonella* a gizzard with an organization precisely similar to that of *Bowerbankia*.* The stomach is a large thick-walled sac, and may be divided into two portions, first a nearly cylindrical prolongation (Pl. V, fig. 5; IX, fig. 7, *g*), which by one extremity immediately receives the œsophagus, while by the other it is continuous with the remaining portion of the stomach; it may be called the *cardiac* cavity of the stomach. The second division (*g'*) forms the greater portion of the stomach; it is also of a nearly cylindrical form; but it is longer and wider than the cardiac cavity with which its axis is nearly continuous; it terminates below in a rounded *cul-de-sac*; to distinguish it from the other, I shall call it the *pyloric* cavity of the stomach. Between the cardiac and pyloric cavities there is no marked line of demarcation, the structure of both being quite similar; notwithstanding, however, the similarity of structure, I believe there are physiological grounds for the distinction, for I consider the cardiac cavity as the true homologue of the gizzard in *Bowerbankia*.

On a level with the continuation of the cardiac into the pyloric cavity arises the *intestine* (*h*); it springs from the pyloric cavity, with which it communicates by a very defined orifice (Pl. III, fig. 7, *h'*). The structure of the pylorus is such as to admit of the orifice being dilated or contracted, or even completely closed. The intestine is very wide at its origin, and passes up along the side of the cardiac cavity and œsophagus, rapidly diminishing in diameter till it terminates in a distinct anus by perforating the tentacular sheath just below the mouth, and at the concave side of the lophophore.

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* 'Lehrbuch der Vergleichenden Anatomie,' § 38, Note 1.

b. Gymnolæmata.

In *Paludicella articulata*, the mouth (Pl. X, fig. 5) is a perfectly circular orifice, with slightly projectile margin, and is totally destitute of the valve-like appendage which, unless *Urnatella* should prove an exception, is found in all the other fresh-water species. The upper part of the œsophagus (fig. 3, *f*) is wide, and may perhaps here, more decidedly than in the other species, be distinguished as *pharynx*. It soon contracts into a long narrow tube, which leads to an oval sac (*g*) corresponding to the cardiac cavity of the stomach in the other fresh-water Polyzoa, and to the gizzard in certain marine species. This sac is much more distinct from the great cavity of the stomach than in the other Polyzoa of fresh water. It enters this cavity near its upper extremity, and presents here a well-marked constriction; in extreme retraction of the polypide it is bent back upon the rest of the stomach. The great cavity (*g'*) of the stomach is of a nearly cylindrical figure; from its upper extremity arises the intestine (*h*). This tube presents, just after its origin, a wide dilation, and then suddenly contracting, continues as a narrow cylindrical canal to its termination just below the mouth.

The *histological structure* of the alimentary tube in both the phylactolæmatous and gymnolæmatous forms is somewhat complex. It may, however, be easily enough made out in the different genera. Wherever I have had a good opportunity of examining it, I have succeeded in detecting in the stomach three distinct layers. Internally is a yellowish-brown layer (Pl. III, fig. 7 κ), which is thrown into large longitudinal rugæ. These rugæ become less decided towards the fundus of the stomach, and in *Paludicella* they are entirely absent. This internal layer is composed of easily separable spherical cells (Pl. II, figs. 6, 7), containing a colourless fluid, in which floats a secondary cell, with yellowish-brown contents. When the animal has been left long without food, the brown matter disappears from the cells, and the stomach becomes colourless. The inner layer of the stomach is thus distinctly glandular, and may be fairly viewed as the representative of a liver, the cells with brown contents being manifestly true secreting cells, destined for the elaboration of the bile, and capable of being set free by the rupture of the cell which encloses them.

This layer passes externally into a more compact layer (Pl. III, fig. 7, λ) composed of smaller, simple cells (Pl. II, fig. 8), with colourless contents and a brilliant nucleus.

The third or most external layer is a thin membrane (Pl. III, fig. 7, μ); it possesses also an undoubted cellular structure, it admits of being traced uninterruptedly over the whole tract of the alimentary canal, and, on the application of acetic acid, becomes frequently raised from the subjacent layer. Delicate circular striæ may generally be distinctly observed in it, they may be seen surrounding the stomach, and are probably muscular fibres; they are particularly evident in *Alcyonella* and *Plumatella* towards the fundus of the stomach, they become less distinct as we ascend toward the œsophagus, and totally disappear from this tube and from the rectum. The fundus of the stomach appears to differ from the rest of the alimentary canal in structure and function; the well-defined longitudinal rugæ and deep brown colour of the internal layer of the stomach nearly disappear in it, and, during the process of digestion, we may perceive that the peculiar peristaltic action of the walls is more marked in it than in any other part of the gastric cavity, while it is every now and then separated from the rest of this cavity by a momentary hour-glass constriction.

In the œsophagus there are only two layers (Pl. III, fig. 7, λ', μ'). These correspond to the middle and external layers of the stomach, the former being here largely developed (λ'), while the internal or hepatic layer of the stomach is entirely absent, and there are no longitudinal rugæ. The mouth and upper part of the œsophagus are in all the genera clothed with vibratile cilia, but I could detect no appearance of cilia further than a short distance down this tube.

The structure of the intestine closely resembles that of the œsophagus; vibratile cilia however, are altogether absent. In *Cristatella*, the cells of the internal layer corresponding to the middle layer of the stomach are large, and filled, in the well-fed animal, with a clear greenish-blue fluid.

With the exception of the mouth and upper portion of the œsophagus, no part of the alimentary canal is ciliated in the phylactolæmatous fresh-water Polyzoa. In *Paludicella* however, the stomach in the immediate neighbourhood of the pyloric orifice is lined with long vibratile cilia (Pl. X, figs. 3, 4), by which portions of alimentary matter, pushed onwards by the peristaltic contractions of the stomach, are kept in a constant state of active rotation previously to their being delivered into the intestine. The entire tract in all the genera examined is highly irritable, the presence of alimentary matter stimulating it to rapid and vigorous contraction.

The whole course of the alimentary matter, from the moment of its prehension to its final ejection, may be easily witnessed in many of the fresh-water Polyzoa. If a polypide of *Plumatella repens* be watched while in an exserted state, different kinds of Infusoria and other minute organic bodies may be observed to be whirled along in the vortices caused by the action of the tentacular cilia, and conveyed to the mouth, where many of them are at once seized and swallowed, and others rejected. The food having once entered the œsophagus, experiences in this tube no delay, but is rapidly conveyed downwards by a kind of peristaltic action, and delivered to the stomach; and at the moment of the passage of the alimentary matter from the œsophagus into the stomach the cardia may be observed to become more prominent. In the stomach the food is destined to experience considerable delay; it is here rapidly moved up and down by a strong peristaltic action, which first takes place from above downwards, and then inverting itself, propels the contents in an opposite direction. Every now and then the fundus of the stomach, which, as has already been said, seems to perform some function distinct from that of the rest of the organ, seizes a portion of the alimentary mass, and retains it for a moment by an hour-glass restriction separate from the remainder, and then powerfully contracting on it, forces it back among the other contents of the stomach. All this time the food is becoming imbued with the peculiar secretion of the gastric walls, and soon assumes a rich brown colour. After having thus undergone for some time the action of the stomach, the alimentary matter is delivered by degrees into the intestine, where it accumulates in the wide pyloric extremity of this tube. After continuing here for a while in a state of rest, and probably yielding to the absorbent tissues its remaining nutritious elements, portions in the form of roundish pellets become separated at intervals from the mass, and are slowly propelled along the tube towards the anus, where, having arrived, they are suddenly ejected into the surrounding water and rapidly whirled away by the tentacular currents. It was these excrementitious pellets that Turpin mistook for unarmed ova in *Cristatella*.

(3.) *Organs of Respiration and Circulation.*

Upon the tentacular crown and the walls of the perigastric space would seem, among the Polyzoa, chiefly to devolve the function of bringing under the influence of the aerating medium the nutritious fluid of their tissues.

The tentacular crown of a Polyzoon consists of two portions, namely, first, a sort of stage or disc (the *lophophore*) (Pl. II, fig. 24; IX, fig. 7; X, figs. 3, 4, *k*) which surrounds the mouth; and secondly, a series of *tentacula* (*l*) which are borne upon the margin of the lophophore. The lophophore is throughout almost the entire class of an orbicular figure; but in the fresh-water genera *Cristatella*, *Lophopus*, *Plumatella*, and *Alcyonella*, its neural margin, or that which corresponds to the side of the rectum, is extended into two long triangular lobes or arms, so as to cause the lophophore in these genera to present the form of a deep crescent, round whose entire margin the tentacula are borne in one continuous series. This condition of the lophophore is found in no marine species. In *Fredericella* the arms of the crescent are obsolete, and the lophophore here may, on a superficial view, appear orbicular; but a careful examination will render manifest its departure from the orbicular form, the side corresponding to the arms of the crescent being slightly prolonged, while the bilaterality is rendered still more decided by the presence of an epistome. *Paludicella* is the only fresh-water genus, if we except *Urnatella*, not yet sufficiently examined, in which not the slightest trace of bilaterality can be detected (Pl. X, fig. 5). With the exception of *Pedicellina*, which presents a condition of the lophophore altogether unique and exceptional,* and some other marine genera in which a slight tendency to assume a bilateral form may be observed, but which never possess an epistome, the lophophore in the marine genera is always orbicular. The lophophore in all the genera forms the roof of the perigastric space; in the species with crescentic lophophores the arms of the crescent are tubular and open into this space; the interior of the arms is clothed with vibratile cilia.

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* The structure of *Pedicellina* has been hitherto entirely misunderstood. I have had an opportunity of carefully examining this Polyzoon, and as it is constructed on a plan quite peculiar, and may tend to throw light on the morphology of other types, it may not be out of place to give a description of it here.

The general appearance of *Pedicellina* is that of a gymnolæmatous Polyzoon with its nearly spherical cell seated on the extremity of a long peduncle. The gymnolæmatous character, however, is wholly deceptive, and depends on a remarkable condition of the lophophore, which, though at first sight orbicular, is truly bilateral and phylactolæmatous, but nevertheless constructed on a type peculiar to itself, and of which no other Polyzoon affords any example, unless further examination shall show a similar disposition in *Urnatella*.

The two arms of the lophophore have the tentacula confined to their outer margin. They are

The tentacula are tubular, closed at their free extremity, and opening by the opposite through the lophophore into the perigastric space; in all the Polyzoa they are armed upon their opposed sides with vibratile cilia, arranged in a single series, and vibrating towards the remote extremity of the tentacle upon one side, and towards the base on the other. Two very distinct layers (Pl. IX, fig. 5) enter into the structure of the tentacula. The external layer consists of rounded cells filled with a colourless fluid, and often presenting a bright nucleus. Some of those cells which lie upon the back of the tentacle become in certain genera enlarged, giving a vesicular appearance to the organ; this is particularly evident in *Cristatella*. The internal layer is a delicate transparent membrane, in which I could detect no trace of

approximated at their extremities, and thus, instead of constituting an open crescent, they form a ring enclosing a space which embraces within it the termination of the intestine.

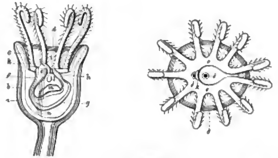

Fig. 3.

Fig. 4.

PLAN OF PEDICELLINA.

Fig. 3. Longitudinal section. Fig 4. Front view of lophophore and contiguous parts.

Ectocyst. *b.* Endocyst. *c.* Invaginated portion of endocyst adherent to the bases of the tentacula and entering into the formation of the cup. *d.* Muscular fibres surrounding the margin of the cup. *e.* Mouth. *f.* Œsophagus. *g.* Stomach. *h.* Rectum. *i.* Anus. *k.* Epistome. *l.* Ganglion. *m.* Generative organ. *n.* Retractor muscle. *o.* Lophophore.

The tentacula are connected to one another at their base by a membrane which adheres to their back, extending forwards for about one third of their length, and constituting a cup. This membrane passes uninterruptedly from the extremity of one arm of the lophophore to that of the other, thus binding together the two tentacula which spring from the points of the arms, and completing the tentacular crater so as entirely to disguise the hippocrepian character, and give to the crown of tentacula the form presented by the infundibulate genera. The result of this arrangement is, that the anus presents the anomalous condition of opening *within* the tentacular crater. It will be easily seen, however, that the position of the anus though within the circle of tentacula is still properly external to the lophophore, and thus really occupies its normal position in the concavity of the crescent.

The membranous cup which surrounds the base of the tentacular crown is not homologous with the calyx of the ordinary hippocrepian Polyzoa, but would seem rather to represent a permanently invaginated portion of the endocyst, with which, however, a true calyx equivalent to that of the fresh-structure; it resists putrefaction longer than the external cellular layer, and forms the immediate walls of the tubular cavity. Nervous filaments, and certain bands, probably muscular, to be presently described, may be traced as far as the root of each tentacle, and doubtless also enter into its structure. In *Cristatella*, a minute cavity, which looks as if it were cut off from the rest of the tube, may be very plainly seen in the extremity of each tentacle; this condition would also seem to exist in other genera, but it is nowhere so well marked as in *Cristatella*.

In all the fresh-water genera, with the exception of *Paludicella*, and possibly of *Urnatella* the entire plume of tentacula is surrounded at its base by an exceedingly delicate

water Phylactolæmata is probably united. In order to understand this relation, it is necessary to conceive of the polypide as *partially retracted*; the invaginated portion of the endocyst must then be viewed as adherent to the external portion externally, and to the tentacula (and calyx?) internally.

From this arrangement it is obvious, that the exsertion and retraction of the polypide must be very limited. When the polypide desires to withdraw under cover of the cell, the free portion of each tentacle is rolled inwards as far as the margin of the calyx-like cup, and then the mouth of the cup is closed over the whole by the action of a well-developed sphincter muscle, the tentacular crown being at the same time slightly drawn backwards by some retractor fibres, which may be seen extending from the upper part of the pharynx to the base of the cell. The sphincter would seem to represent a condensed band of the parietal muscles of other Polyzoa, or it is probably homologous with the vaginal sphincter, which is nothing more than a peculiar development of these muscles in the invaginated endocyst. The retractor fibres are obviously homologous with the great retractor muscles of the others.

The mouth, which occupies its normal position in the body of the lophophore, opens into an œsophagus, which after a short course terminates in the stomach. This is a large sac which lies in the bottom of the cell; close to the pyloric orifice it becomes much constricted, and this constricted portion passes into the intestine whose origin is nearly on a level with the cardiac orifice, but separated from it by a considerable space. The intestine passes first forwards and towards the neural side, then turns towards the mouth to open after a wide dilation between the arms of the lophophore in the bottom of the tentacular crater.

The concave margin of the body of the lophophore is raised into a kind of thickened rim, which arches over the mouth, so as to constitute an epistome thickly ciliated on its oral aspect, but not provided with muscles like the epistome of the ordinary phylactolæmatous Polyzoa.

The hepatic layer, which, in other Polyzoa, forms a continuous lining extending over nearly the whole of the internal surface of the stomach, is here confined to the anterior portion of this sac, in the space between the cardiac and pyloric orifices, where it constitutes a dark brown glandular mass composed of distinct cells, which are filled with the characteristic brown secretion. The rest of the stomach, as well as the œsophagus, is lined with vibratile cilia, which are especially developed in the vicinity of the pylorus.

The ovary is an irregularly shaped mass, situated between the cardiac and pyloric orifices of the stomach, and the animal appears to be unisexual, the testis occupying the place of the ovary in other individuals.

The stalk on which the cell containing the polypide is elevated, constitutes a very characteristic feature of *Pedicellina*. It is a tube in whose walls both ectocyst and endocyst can be demonstrated; it contains straight muscular fibres, which extend from the base of the cell to the point of attachment of the stalk; and besides these, more delicate circular fibres can also be detected in it. By the action of the straight and circular fibres, various motions, especially those of flexion and extension, can be transparent membrane in the form of a cup or *calyx* (Pl. II, fig. 24; V, fig. 5; IX, fig. 7, *m*). This cup is adherent to the back of the tentacula, and its margin is in most instances prolonged more or less upon each tentacle, as a narrow triangular process, so as to present a sort of scalloped or festooned appearance; the festooning of the margin is most marked in *Fredericella*; in some species of *Plumatella* it is scarcely perceptible. A high power of the microscope, and carefully adjusted illumination, will enable us to detect in the calyciform membrane certain delicate anastomosing lines. These appear to indicate the surfaces of contact of cells of which the membrane would thus seem to be composed, they are particularly evident in *Cristatella*. It is curious enough that the calyx should be exactly coincident with the presence of an epistome in all the fresh-water Polyzoa; unless *Urnatella* should prove to be an exception, which is not likely, though we are not yet sufficiently acquainted with the structure of the genus to include it in this generalization. In no marine polyzoon has a calyx yet been detected, unless we admit the by no means improbable supposition that it enters partly into the composition of the calyx-like cup which surrounds the base of the tentacles in *Pedicellina*, the only marine genus in which an epistome is also represented.*

The perigastric space, and interior of the tentacula and lophophore, all freely communicate with one another, and are filled with a clear fluid, in which float numerous particles of very irregular form and size. In this fluid may be observed a constant rotatory motion, rendered apparent by the floating corpuscles as they are whirled away under the influence of the currents. That the fluid thus contained in the perigastric space, and thence admitted into the tentacula, consists mainly of water which had obtained entrance from without, there can, I think, be little doubt, and yet I have in vain sought for any opening through which the external fluid can gain admittance to the interior. I have allowed the transparent genera *Cristatella* and *Lophopus* to remain many hours in carmine without being able to detect a single particle of this pigment in the perigastric space, though I have seen this space rapidly empty itself on the removal of the animal from the water, and again fill on restoring it to its natural element. Van Beneden† believed that he had detected in *Alcyonella* apertures, which he names "bouches aquifères," at the base of the tentacula; but this distinguished naturalist is certainly

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given to the stalk, and these motions, when witnessed in a living and active group of *Pedicellinæ*, present an appearance in the highest degree novel and interesting.

The stalk of *Pedicellina* must be viewed as homologous with the posterior part of the cell in the unstalked forms of Polyzoa. It is simply that portion of the cell become so much constricted as to be no longer capable of containing the polypide, which is in consequence pushed onwards into the wider portion which now constitutes the proper cell. The muscles of the stalk have their representative in the muscles developed in the walls of the cell of Polyzoa.

Between the œsophagus and rectum, but separated from the latter by the whole mass of the generative system, is the nervous ganglion, close to which, and lying between it and the œsophagus, is a peculiar organ in the form of a minute tubular cavity clothed with actively vibrating cilia. I was unable to follow this organ through its whole extent, or determine its exact relations, as it appeared to lose itself beneath the opacity of the surrounding structures. Its situation would suggest the probability of its being an organ of sense. It is possible, however, that it is a portion of a more extensive system of tubes, a supposition which some appearances seem to warrant, and then we might perhaps view it as indicating the presence of a water-vascular system.

* See previous note.

† Quelques Observations sur les Polypes d'eau douce, 'Bull. de l'Acad. Roy. de Bruxelles,' 1839.

here in error, as indeed he himself subsequently admits. Meyen asserts the existence of an aperture in the vicinity of the anus, through which, he tells us, he has witnessed the escape of an egg in *Alcyonella*,[*] and Siebold admits the correctness of this statement, and considers the aperture described by Meyen to be that through which the external water is admitted to the interior.[†] I have, however, fully convinced myself that no such aperture exists, and the phenomenon described by Meyen must certainly be due to an accidental rupture of the tissues, though Van Beneden describes the passage of the eggs through an aperture similarly placed in the marine genus *Laguncula*.[‡] It is possible that certain apertures may exist in some of the tissues of the animal so minute as to defy our attempts at detection, and yet capable of permitting a passage of fluid; some facts already recorded (page 13), would seem to point to the existence of a system of tubes in the substance of the endocyst, which may afford the necessary channels of communication, or it may be that it is in simple transudation through the walls of the alimentary canal that we are to seek for the true mode in which the external water passes into the perigastric space.

The real signification of the perigastric fluid is a point whose determination must be of great importance in the physiology of the Polyzoa. As has just been said, it is by no means homogeneous, and numerous corpuscles of very various and irregular shape may be observed to float through it and be carried about by its current. Some of these corpuscles are, doubtless, spermatozoa; others are of no definite shape, and look like minute portions of the tissues separated by laceration.

If it be admitted, as I think it must be, that the perigastric fluid consists mainly of water which has obtained entrance from without, it then corresponds to a true aquiferous system subservient to a respiratory function. But it also without doubt receives certain products of digestion which had transuded through the walls of the alimentary canal; it thus connects itself with the digestive system. It is, moreover, the only representative in these animals of a sanguiferous circulation, for in the Polyzoa there is certainly no trace of a heart, nor can anything referable to a true vascular system be detected. The perigastric circulation, therefore, unites in itself the triple function of a chyliferous, sanguiferous and respiratory system. And the fluid in question would correspond to the "chyle-aqueous fluid," which plays so important a part in the economy of the lower animals, and whose nature has been recently well elucidated by the researches of Dr. Williams.[§]

The next point of interest to determine, with regard to the perigastric fluid, is the cause of the peculiar currents observed in it. These currents, which extend into the tentacular crown, were long ago observed by Trembley[‖] in *Lophopus crystallinus*; but this author contented himself with simply recording their existence, and made no attempt to explain them. Nordmann,[¶] who observed them both in fresh water and marine genera, not being able to detect any trace of cilia or other moving power, compared them to the currents in the cells of *Chara*. That they are produced partly by the action of vibratile cilia, and partly by the muscular contraction of the endocyst, there can, however, now be no doubt. Van Beneden[*] tells us that he has seen these cilia, not only on the walls of the perigastric space, but on the external surface of the alimentary canal. I cannot, however, confirm their existence in the latter situation; indeed, my own observations are entirely opposed to their presence on the alimentary canal; and I cannot help thinking that this statement of Van Beneden is connected with some error of observation. I have, however, most distinctly seen them on the inner surface of the upper part of the tentacular sheath in certain species during the exserted state of the polypide (Pl. IV, fig. 4); on other parts of the endocyst I have not succeeded in detecting them by direct observation; but the peculiar acceleration which the motion of the circulating corpuscles experiences when these approach the walls of the perigastric space, plainly indicate the presence of vibratile cilia in this situation.

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[*] Meyen, Naturgeschichte der Polypen, Isis, 1828.

[†] *Loc. cit.* § 41.

[‡] Recherches sur l'Org. des Laguncula, 'Nouv. Mém. de l'Ac. Brux.,' xviii.

[§] On the Blood proper and Chyle-aqueous Fluid. 'Phil. Trans.' 1852.

[‖] Mém. pour l'Hist. des Polypes d'eau douce.

[¶] Micrographische Beiträge, Bd. ii. p. 75.

(4.) *Muscular System.*

The muscular system is highly developed; we shall first consider it in the phylactolæmatous Polyzoa, and afterwards attend to its disposition in *Paludicella*.

a. Phylactolæmata.

In all these the disposition of the muscles is exceedingly similar; eight distinct sets may be considered as more or less positively demonstrated.

(1.) *Retractor Muscles of the Polypide.*

These, which are the largest and most powerful muscles of the animal, consist of two fasciculi (Pl. IV, fig. 4; V, fig. 5; IX, fig. 7, *a*), which arise far back from the inner surface of the endocyst, and thence pass forwards, one along each side of the alimentary tract, to be inserted into the upper part and sides of the œsophagus. A few accessory fasciculi (Pl. V, fig. 5, *c*) may also be generally seen arising near the origin of the former, and inserted into the sides of the stomach. The *action* of the retractor muscles is very obvious; having a comparatively fixed point of attachment near the bottom of the cell, they retract the whole alimentary canal with the tentacular crown, so as to place them in a state of security in the interior of the cœnœcium.

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[*] Quelques Observations sur les Polypes d'eau douce, *loc. cit.*

(2.) *Rotatory Muscles of the Crown.*

These also consist of two fasciculi (Pl. IV, fig. 4; V, fig. 5; IX, fig. 7, *p*), which arise along with the set just described, and passing forward in company with these, separate from them at some distance below the crown, and thence pass outwards to the right and left, to be inserted each into its own side of the lophophore. *Action*: they rotate the tentacular crown, and depress the lobes.

(3.) *Tentacular Muscles?*

Under this name may perhaps be described a set of delicate parallel bands (Pl. V, fig. 5, *q*), to which attention was first directed by Van Beneden, and which may be observed running from below upwards upon the margin of the lophophore; these bands are continuous with one another below, and when they arrive at the intervals between the roots of the tentacula, each divides into two others, which would appear to run along the opposed sides of two neighbouring tentacula. M. Van Beneden considers them as muscles destined to act on the tentacula; but it must be admitted that we are scarcely justified in pronouncing decidedly on the muscular nature of these bands, which certainly do not present any distinctly fibrous structure. If they be truly muscular, it is to their action that the various motions observed in the tentacles would seem to be chiefly due. The margin of the lophophore in the interval of the bands presents an oval transparent space, which looks exactly like an aperture, and it would seem to be these spaces which M. Van Beneden has taken for "aquiferous mouths," after very careful examination, however, I have convinced myself that no aperture exists here, the apparent mouths being merely transparent spaces in the lophophore.*

(4.) *Elevator Muscle of the Epistome.*

This is a small but very evident fasciculus (Pl. II, fig. 24, *r*), occupying the interior of the epistome, and visible through its transparent walls; it arises from the lophophore within the cavity of the epistome, and then passing obliquely across the cavity, is inserted into the inner surface of the oral wall of the epistome. *Action*: it elevates the epistome, and draws it away from the mouth.

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* M. Van Beneden has himself given up his earlier views upon this point, and has referred the appearance in question to its proper cause. Dumortier and Van Beneden, Hist. Nat. des Polypes composés d'eau douce, 2de partie, 'Mém. de l'Acad. Roy. des Sc. et Belles-lettres de Bruxelles,' Compl., t. xvi.

(5.) *Anterior Parieto-vaginal Muscles.*

These consist of numerous short bands (Pl. IV, fig. 4; V, figs. 5, 6; IX, fig. 7, *s*), which arise all round from the inner surface of the endocyst, commencing close to the line of invagination, and extending for some distance backwards. From this origin they pass transversely inwards, and are inserted into the opposed surface of the invaginated endocyst. Their *action* will dilate the invaginated endocyst, and assist in keeping it permanently inverted.

(6.) *Posterior Parieto-vaginal Muscles.*

These consist of several radiating bands (Pl. IV, fig. 4; V, figs. 5, 6; IX, fig. 7, *t*), longer and stronger than the last, behind which they arise, from the inner surface of the endocyst in a single plain perpendicular to the axis of the cell, and thence passing upwards and inwards, are inserted into the sheath in a plane parallel to that of their origin, and just behind the termination of the anterior parieto-vaginal muscles. Their *action* steadies the sheath, and regulates its position during the protrusion of the polypide, while they form a fixed plane on which it may roll outwards with the polypide in the act of protrusion.*

(7.) *Vaginal Sphincter.*

The vaginal sphincter is a circular band (Pl. V, fig. 6, *u*) surrounding the termination of the invaginated endocyst at the point where the latter passes into the tentacular sheath. Though a contraction of the endocyst at this spot, as if occasioned by the action of a powerful sphincter, may be always observed when the polypide is completely retracted, yet the demonstration of an actual muscle is by no means easy. I have, however, convinced myself of the existence of a distinct structure at the place where the contraction occurs, and, though the presence of fibres is but obscurely indicated, I have no hesitation in viewing this structure as a sphincter muscle on which the contraction in question is dependent. The *action* of the sphincter closes the sheath after the recession of polypide, and thus protects the latter from all annoyance from without.

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* Though I have here described, under the names of superior and inferior parieto-vaginal muscles, the two sets of bands which extend between the walls of the cell and the permanently invaginated portion of the endocyst, I am not by any means without doubts as to their being really muscular, and their action after all may be that of simple ligaments. From the study of development in these Polyzoa, it appears highly probable, as we shall afterwards see, that the invaginated portion of the endocyst is originally separated from the proper walls of the cell by a process of *chorisation*, and while this is taking place the bands in question would seem to be drawn out by the act of separation. There is certainly no reason why muscular fibres may not be developed in them, and the condition of the corresponding parts in *Paludicella*, as well as in certain marine Polyzoa, is altogether in favour of their muscularity; but they do not always present the appearance of distinct fibrous fascicles, and I have been unable to detect in them the striæ, or see them breaking into the discs, which may be observed in the great retractors of the polypide.

(6.) *Parietal Muscles.*

In the description of the histological structure of the endocyst, muscular fibres (Pl. V, figs 5, 6, *v*) were mentioned as entering into the composition of this tunic, and taking a transverse direction round the cell. These may be designated by the name of *parietal muscles*. They may generally be seen very distinctly towards the anterior extremity of the cell, but it is not always easy to determine how far backwards they extend, as in most cases, the internal structures soon become concealed under the increasing opacity of the superjacent tissues. In the more transparent genus *Lophopus*, they seem to be present throughout the whole endocyst. By their *action* they evidently constrict the endocyst in a transverse direction, and thus aid in the protrusion of the polypide. A muscular tissue is also very evident in the walls of the stomach; this has already been described in connection with the histology of the alimentary canal, and need not be further referred to here.

b. Muscles of Paludicella.

The muscular system of *Paludicella* differs in some important points from that of the species with bilateral lophophores. The muscles may here be divided into five sets:

(1.) *Retractor Muscle of the Polypide.*

This (Pl. X, figs. 3, 4, *a*) resembles in attachments and use the corresponding muscle in the other species, but is not so distinctly divided into two separate fasciculi.

(2.) *Anterior Parieto-vaginal Muscles.*

These constitute four strong fasciculi (Pl. X, figs. 3, 4, *e*), which, arising from the sides of the cell near the top, are inserted into the opposed surface of the invaginated endocyst. The fibres of each fasciculus are inserted one after another in a straight line, commencing near the line of invagination, and extending for some distance down the invaginated tunic. These four lines of insertion are placed at nearly equal distances from one another, and thus cause the orifice and invaginated tube to assume a regular quadrilateral figure. The corneous ribs already described correspond to the centre of the intervals between the insertion of the muscles.

Mr Hancock[*] enumerates, under the name of superior tube retractors, two small additional fasciculi, which he describes as originating below those just mentioned, and as inserted also below them into the invaginated tube, their insertion becoming of course superior or anterior to them when the tube is evaginated during the exserted state of the polypide. The marine Polyzoa certainly afford an analogy for the existence of these muscles; but, though I have carefully sought for them in *Paludicella*, I have not succeeded in detecting them here as distinct fasciculi, and I prefer viewing the "superior tube-retractors" of Hancock as some of the posterior fibres of the anterior parieto-vaginal muscles. The *action* of the anterior parieto-vaginal muscles assists in the invagination of the tube, and dilates it when completely retracted; they thus act as antagonistic to the vaginal sphincter, while the posterior fibres will check the complete evagination during exsertion.

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[*] Loc. cit.

(3.) *Posterior Parieto-vaginal Muscles.*

These are about four thin fasciculi (Pl. X, figs. 3, 4, *t*), first pointed out by Mr Hancock; they arise from the inner surface of the endocyst near the top of the cell, two upon the hæmal, and two upon the neural side, and are inserted into the opposed surface of the tentacular sheath. Their *action* checks the complete evagination of the sheath in the way we shall presently see.

(4.) *Vaginal Sphincter.*

This was also pointed out for the first time by Mr. Hancock. It consists of a set of fibres (Pl. X, fig. 3, *s*) which run transversely round the invaginated tunic. I have not succeeded in dividing it into an inferior and superior set, as described by Mr. Hancock. Its *action* closes the invaginated endocyst after the retraction of the polypide.

(5.) *Parietal Muscles.*

These are numerous, short but strong, and very evident fibres (Pl. X, figs. 3, 4, *e*), which run transversely in the endocyst in small groups of two or three fibres each, embracing about a third or fourth of the circumference of the cell. Their *action* compresses the endocyst, and by thus diminishing the cavity of the cell, effects the exsertion of the polypide.

The description now given of the muscular system in the fresh-water Polyzoa, will enable us to understand the mechanism by which the protrusion and retraction of the polypide are effected.

The grand agency to which we must assign the protrusive act, is without doubt the contraction of the endocyst effected by the parietal muscles, or by the general contractility of the tunic itself; and, indeed, it does not seem possible to refer the act of protrusion to any other cause than the consequent pressure of the perigastric fluid against the body of the polypide, and the necessary compulsion of the latter to move in the direction of least resistance, or through the orifice of the cell: for the mere straightening of the œsophagus, to which Dr. A. Farre* attributes so large a share in the production of this act among the marine Polyzoa, can at most raise the lophophore and tentacula a very short distance, and can exercise no exsertile influence on the inferior portion of the polypide, which, indeed, it must rather tend to repel into the bottom of the cell; while in all the fresh-water genera, with the exception of *Paludicella*, the œsophagus, in the retracted state of the polypide, is scarcely at all bent, so that here its agency in exsertion is at once out of the question.

Let us suppose the polypide withdrawn into the recesses of the cell, and that hunger or some other stimulus impresses on it a desire of protrusion. The endocyst now contracts on the perigastric fluid, which, pressing on the polypide, forces it onwards towards the orifice; at the same time the vaginal sphincter relaxing, affords to the cone of tentacula a free passage through the tube of the inverted endocyst.

The succeeding steps in the process take place somewhat differently in the two great groups. In *Plumatella* and the other fresh-water phylactolæmatous genera, as the polypide continues to advance from the cell, the invaginated endocyst is gradually carried out with it by a process of evagination, which proceeds up to a certain point, where it is stopped by the action of the posterior parieto-vaginal muscles, which, by straining upon the invaginated membrane, had already afforded a fixed line, on which it rolled outwards during eversion. This line constitutes the extreme limit of eversion, and that portion of the invaginated endocyst which lies between it and the mouth of the cell remains permanently invaginated. In *Paludicella* the process is somewhat more complicated; here the relaxation of the anterior parieto-vaginal muscles permits the eversion of the endocyst, but only to a limited extent, for the posterior fibres of these muscles soon check its further progress, keeping one portion permanently invaginated, and affording a fixed point on which the remainder may roll outwards. This second portion of the invaginated membrane, which in the retracted state constitutes the tentacular sheath, continues to be carried outwards by the advancing polypide, the posterior parieto-vaginal muscles slowly relaxing to admit of it. These muscles, however, after a certain time refuse to suffer further relaxation, and thus afford a second check to the evagination of the membrane. Thus we have two small permanent invaginations existing after the completion of the protrusive act (Pl. X, fig. 4). One of these is placed within the other and gives rise to the membranous cup which projects from the lips of the orifice in the exserted state of the polypide. This cup, therefore, which may plainly be seen under a proper illumination to consist of a membrane doubled into itself, is nothing else than the imperfectly evaginated tentacular sheath. It may be witnessed during the act of protrusion in *Plumatella* and other genera; but in these it is a mere temporary condition, being obliterated on the completion of the act. When the protrusion of the polypide is completed, the last act in all the species is the display of the tentacula, which had previously been all drawn together into a close cone or cylinder, and scarcely any more pleasing sight can be presented to the microscopic observer than the spreading out of the beautiful crown and the excitement of the vortices in the surrounding fluid, by the countless cilia which instantly commence their untiring vibration on the sides of the tentacula.

The mechanism of retraction is easily understood. Here the perigastric fluid being an longer pressed upon by the contraction of the endocyst, the great retractor muscles act directly on the polypide and withdraw it into the cell, the anterior and posterior parieto-vaginal muscles in *Paludicella* drawing after it as it descends that portion of the endocyst which had been carried out during protrusion; in the other genera, however, the anterior muscles would seem to take no part in this act. When the retraction is complete, the sphincter closes the tentacular sheath, and the polypide rests secure in the recesses of the cell.

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* 'Observations on the Minute Structure of some of the higher forms of Polypi,' 'Philosophical Transactions,' 1837.

The muscles of these animals are especially interesting in a physiological point of view, for they seem to present us with an example of true muscular tissue reduced to its simplest and essential form. A muscle may, indeed, here be viewed as a beautiful dissection far surpassing the most refined preparation of the dissecting needle, for it is composed of a bundle of elementary fibres, totally separate from one another through their entire course. The fibres of the great retractor muscle are distinctly marked with transverse striæ, a condition, however, which is not at all times equally perceptible; and some of our best observers have denied to the Polyzoa the existence of striated fibre. I have, however, by repeated observations, satisfied myself of the striated condition of the fibre in the great retractor muscle in the fresh-water genera (Pl. IX, fig. 6). In *Paludicella*, I have seen this state beautifully marked through the pellucid cell in the whole extent of the retractor muscle while the fibres were on the stretch in the exserted condition of the polypide; and in all the other genera which I have had an opportunity of examining it has, under favorable circumstances of observation, been more or less visible. In order to witness it in perfection, the fibre must be on the stretch; for when this is torn from its attachments or lies relaxed on the bottom of the cell, the striæ become very obscure. When the broken extremity of a fibre is examined, the fracture will be found to have occurred in a plane perpendicular to the axis of the fibre, never presenting an uneven or lacerated surface, and a marked tendency to separate into discs may be recognised in the detached and broken fibre. Indications of a very delicate investing sarcolema may also be occasionally witnessed. When the fibre is in an uncontracted state, it would seem to be perfectly cylindrical; and the normal act of contraction is so momentary that its condition during this act cannot be witnessed. When, however, the living polypide is torn from its cell, the ruptured fibres which continue attached to its body are thrown into a state of spasmodic contraction, and then it will be seen that they lose their cylindricity and become irregularly swollen at intervals, while the whole fibre has much increased in thickness: in this state we may also observe it obscurely striated. The swellings here visible in the contracted fibre are quite different from the peculiar knots described by Dr. A. Farre, in the muscles of the marine Polyzoa. Such knots do not exist in the fresh-water species—at least I have never seen them—with the exception, perhaps, of certain little swellings, which may be occasionally witnessed in the parietal muscles of *Paludicella* and in the superior parieto-vaginal muscles of *Plumatella*. In *Paludicella* I have witnessed a curious phenomenon presented by the muscular fibre. In this polyzoon the fibres of the great retractor muscle, while lying relaxed in the bottom of the cell after the retraction of the polypide, may frequently be seen to present a singular motion, impressing you with the idea of a cluster of writhing worms. It is only in the great retractor muscles that I have succeeded in detecting the striated condition of the fibre.

It has been already shown (p. 12) that the fibres occurring in the endocyst (parietal muscles) are composed of very distinct fusiform nucleated cells, entirely resembling the muscle-cells of the involuntary fibre in the higher animals.

The existence of striated fibre in the Polyzoa was first noticed by Milne-Edwards, who detected it in *Eschara*,* and Mr. Busk has since described and figured the same form of tissue in *Anguinaria spatulata*, *Notamia bursaria*, and other marine Polyzoa.†

(5.) *Organs of the Life of Relation.*

I have succeeded in making out a distinct nervous system in all the genera with the exception of *Urnatella* and *Pectinatella*, which I have had no opportunity of examining, and of *Paludicella*, in which I have not as yet been able to effect any satisfactory demonstration of its existence. In the phylactolæmatous species, there may be seen attached to the external surface of the œsophagus, on its rectal aspect just below the mouth, an oval body of a yellowish colour, and presenting a somewhat lobed outline (Pl. II, fig. 24; V, fig. 5; IX, fig. 7, *m*). That it is a nervous ganglion there cannot be any doubt, and I have succeeded in distinctly tracing nervous filaments in connection with it. In *Cristatella*, *Lophopus*, and other genera with crescentic lophophores, the ganglion may be seen giving off from each side a rather thick chord (Pl. II, fig. 24, *x*) which immediately enters the tubular arms of the lophophore, and then, after giving off a branch which runs along the root of the lophophore towards the hæmal side, and which sends in its passage a filament to each tentacle on this side of the lophophore, it continues its course (*x*′) along the roof of the arms to their extremity, sending off at regular intervals a filament to each tentacle upon the outer margin of the arm. When it arrives at the extremity of the arm it turns on itself, and in its retrograde course gives off similar filaments to the tentacula placed upon the inner margin. I have thus traced it back to the base of the arms, but have here failed in my attempts to follow it further; it is, however, highly probable that it passes across the lophophore to unite with the corresponding chord of the opposite side. The tentacular filaments are directed towards the intervals between the tentacula. The ganglion also sends off a filament (*y*), which dives into the substance of the œsophagus just behind the mouth; it is probably distributed to this tube, and to the mouth and epistome, but I have not succeeded in detecting anything like a nervous collar surrounding the œsophagus at this place. There is no other ganglion than the one just described; and, unless it be the epistome, and possibly in *Pedicellina* a peculiar ciliated organ‡ in the neighbourhood of the ganglion, nothing which can with any real probability be referred to an organ of special sense has as yet presented itself in any polyzoon.

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* Milne-Edwards, Recherches Anatomiques, Physiologiques et Zoologiques sur les Eschares, 'Ann. des Sci. Nat.,' 2de série, t. vi.

† Busk in 'Transactions of the Microscopical Society of London,' vol. ii.

‡ See note, p. 19.

B. *Organs for the Preservation of the Species and the Anatomy and Development of the Bud.*

(1.) *Ovary and Testis.*

True sexual organs have now been satisfactorily demonstrated in several of the genera of Polyzoa, both fresh-water and marine. In *Alcyonella* and *Paludicella*, I have succeeded in making a careful examination of the generative system. In each of these both ovary and testis are found in the same cell.* During the months of July and August there may frequently be seen in the interior of the cell of *Alcyonella fungosa*, a roundish mass (Pl. III, fig. 7, ψ) attached by a short peduncle to the endocyst at a little distance within the orifice, and corresponding exactly in position to an ordinary bud, with the early stage of which it may indeed be readily confounded. This body is the ovary. It is filled with spherical ova in various stages of maturity. The testicle, which will be found at the same time and in the same cell with the ovary, is developed in the form of an irregular roundish mass (χ), upon a peculiar appendage which is present in all the fresh-water polyzoa I have had an opportunity of examining, and which is always in the form of a long cylindrical, flexible cord, attached by one end to the fundus of the stomach, and by the other to the endocyst near the bottom of the cell. We may, with Huxley, designate this appendage by the term *funiculus*. The testicle is composed of a mass of spherical cells, each of which contains within it numerous secondary cells, "vesicles of evolution." (Pl. XI, fig. 17). The visible contents of the vesicles of evolution consist, at first, of nothing more than a well-defined spherical nucleus, and this is subsequently transformed into a spermatozoal filament, which finally escapes by the rupture of the containing cells (figs. 17—23). The spermatozoal filaments, in this genus, are simple vibrioid bodies (fig. 23) without any terminal enlargement. They present distinct though somewhat sluggish undulatory motions. The distal portion of the testis is more developed than the portion which lies nearer to the stomach of the polypide, and the former portion may generally be seen with the undulating spermatozoa projecting from it on all sides, in the form of a dense villosity (Pl. III, fig. 7, χ), while some of these, already become free (ξ), may be seen carried about in the fluid of the perigastric space, and thus brought in contact with the ovary.

In *Paludicella*, the ovary occupies the same position as in *Alcyonella*, forming an irregularly shaped body (Pl. X, figs. 3, 4, ψ), adherent to the inner surface of the endocyst towards the anterior part of the cell. About the end of June, when I discovered this organ, it was loaded with ova of various sizes, some so small as to require for their detection considerable magnifying powers, while others were almost visible to the naked eye, and seemed ready to burst the restraining membrane of the ovary, and escape into the cavity of the endocyst. Attached by one extremity to the external surface of the stomach, near the commencement of the intestine, and by the other attached to the walls of the cell, and apparently also in connection at this place with the ovary, is a cylindrical flexible chord (*anterior funiculus*) (Pl. X, figs. 3, 4, θ'), which obeys all the motions of the stomach. It exactly resembles that already described as attached to the fundus of the stomach and bottom of the cell in *Alcyonella*.

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* Van Beneden at one time maintained the unisexualism of *Alcyonella*, believing that the testis and ovary always occupy separate cells (Quelques observations sur les Polypes d'eau douce,' 'Bull. de l'Acad. Roy. de Bruxelles,' 1839). In a subsequent memoir (Dumortier and Van Beneden, Hist. Nat. des Pol. comp. d'eau douce, 'Mém. de l'Acad. Roy. de Bruxelles,' tome xvi, Complément) he modifies this view, and comparing the polyzoon in question to plants belonging to the class Polygamia of the Linnean system, he believes that among the different zooids of the same colony, there are some in which the sexes are distinct, and others in which they are united. My own observations, however, are opposed to both these views, and it seems to me evident that the eminent professor of Louvain has not seen the true ovary at all.

The testicle in *Paludicella* is an irregularly lobed mass (Pl. X, figs. 3, 4, χ), attached, like the ovary, to the inner surface of the endocyst. It is situated near the bottom of the cell, and is thus, as in *Alcyonella*, separated, by a considerable interval, from the ovary; it is connected with the stomach by a cylindrical chord, or *posterior funiculus* (Pl. X, figs. 3, 4, θ), similar in all respects to the *funiculus* of *Alcyonella*, and, except in position, to the *anterior funiculus* of the present genus. The testicle was coexistent with the ovary, and was loaded with spermatozoa, multitudes of which projected from its surface, presenting quite the same appearance as in *Alcyonella*, while many had escaped from the testicle, and were observed to be carried along in the currents of the perigastric fluid, or might be seen clustering round the ovary. The testicle is here, as in *Alcyonella*, composed of mother-cells (Pl. XI, fig. 24), containing distinctly nucleated vesicles of evolution. The spermatozoa are formed by the transformation of the nucleus. They have a terminal enlargement of an elongated piriform shape (Pl. XI, fig. 25), and exhibit a constant sinuous or undulatory motion.

(2.) *Embryology and Gemmation.*

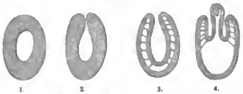
Development of the Ovum.—I have succeeded in tracing the development of the ovum through most of its stages in *Alcyonella fungosa*.

In this polyzoon the mature ovum consists of a granular vitellus, surrounded by a very evident vitellary membrane, on whose internal surface the contents appear frequently to be aggregated in a coarser granular layer (Pl. XI, figs. 26, 27). It presents a large germinal vesicle, and a very distinct germinal spot. After a time the germinal vesicle and germinal spot disappear, and the vitellus undergoes segmentation, and after the mulberry-like condition thus induced has in its turn vanished, we find that the contents of the egg have assumed the form of a roundish or oval body (Pl. XI, fig. 29), richly ciliated on its surface, and provided with a large central cavity, which as yet does not open externally. When liberated from the outer membrane of the ovum, which still confines it, it swims actively through the surrounding water by the aid of the cilia with which it is invested.

As development proceeds, we find the ciliated embryo, while still confined within the coverings of the egg, presenting in some part of its surface an opening which leads into the central cavity; and through this opening an unciliated, hernia-like sac is capable of being protruded by a process of evagination. The unciliated protrusible portion would seem to have been derived by a separation from the walls of the central cavity, and appears therefore to originate by a process of unlining, a true *delamination*.

The following four diagrams will convey a clearer idea than mere description of the probable stages of this process:

Fig. 3.



Diagrams representing the chorization process in the development of the embryo of *Alcyonella*. The stage represented in 3 has not been actually seen, but seems to be the only one that will supply the missing link.

Towards the opening which leads from without into the central cavity the chorization is incomplete, the membrane as it separates being here still held to the walls of the cavity by irregular transverse bands; these bands check the entire evagination of the membrane, but after a time they disappear, and then the unlining and evagination are perfect. In the interior of the protrusible portion, and before the disappearance of the transverse bands, a polypide is developed (Pl. XI, fig. 30). This appears to take place in a manner quite similar to that by which new polypides are produced by gemmation from the walls of the endocystal cavity in the adult. The gemmation of the first polypide is immediately followed by that of another close beside it (Pl. XI, fig. 31), so that the young polyzoon has now the appearance of a transparent, closed sac, filled with fluid, the posterior part ciliated, the anterior destitute of cilia and partially or entirely pushed back into the posterior by a process of invagination; while the sac carries within it two young polypides, which are suspended from the inner surface of the unciliated portion. The arms of the lophophore in the young polypides are at first but slightly developed, and there is as yet no trace of tentacula (Pl. XI, fig. 30^a); these soon present themselves in the form of minute tubercles, at first confined to the body of the lophophore (Pl. XI, fig. 30^b), and then extending along the arms, which at the same time acquire increased proportional length; the tentacula gradually elongate themselves and acquire cilia. At the same time, the alimentary canal, represented at first by a single small cavity, hollowed out in the body of the polypide, is undergoing development, and œsophagus, stomach, and intestine begin to be distinguishable. The great retractor muscles have become evident, and the funiculus may be seen extending from the base of the polypide to the walls of the sac (Pl. XI, fig. 31). The polypides have, at first, no communication with the exterior, but at an early stage the tentacular sheath, with the parieto-vaginal bands, had become evident, and the fluid in which the embryo floats within the walls of the ovum is soon afterwards admitted to the lophophore of the young polypides. The parieto-vaginal bands would seem to be drawn out by a process of separation from the walls similar to that just described.

The embryo is still contained within the external membrane of the ovum, which, however, has become much distended, in accordance with the increasing size of the included parts, and at length, giving way, allows the embryo to escape.

The free embryo (Pl. XI, figs. 32, 33, 33^a, 33^b) now swims actively through the surrounding fluid of the perigastric space. It sometimes remains stationary, with the unciliated portion, in which the polypides are suspended, protruded from the ciliated (Pl. XI, fig. 32); but most frequently this unciliated portion is withdrawn within the ciliated, which is then closed over the aperture (Pl. XI, fig. 33). In this condition the little animal assumes a piriform figure, with the small end corresponding to the aperture. It is thus carried through the surrounding fluid by the vibration of its cilia, performing rapid and elegant motions, always swimming with the broad end foremost, and at the same time revolving gracefully on its axis.

The complete evagination of the unciliated portion is still prevented by the bands already mentioned, but we now find that these bands, which must not be confounded with the permanent parieto-vaginal bands of the adult, have disappeared, and the evagination has become complete (Pl. XI, fig. 34). The unciliated portion is now no longer capable of being withdrawn within the ciliated, with which it has become directly continuous, while the cilia themselves disappear from the ciliated portion, and the entire sac becomes enveloped in an ectocyst, to constitute the cell of the adult polyzoon. The subsequent changes are produced by the gemmation of new polypides, with their proper ectocysts and endocysts.

Plumatella fruticosa presents similar developmental phenomena; the ciliated larva, however, in this species, differs from that just described, in having its polypide single (Pl. XI, fig. 35).

If a specimen of *Alcyonella fungosa* be cut into small pieces, under water, in the month of July or August, the ciliated embryos will be liberated in abundance, and may be examined with facility.

Gemmation.—The development of gemmæ has already been partially traced in the description just given of the larva of *Alcyonella*, we must now follow it, however, a little more in detail, as it is presented by the buds formed in the adult polyzoon.

With the exception of some peculiar forms of gemmæ, to be presently described, these bodies always originate in the endocyst. In *Lophopus*, *Alcyonella*, *Plumatella*, and *Fredericella*, they occur without any very regular order near the orifice of the cell. In *Cristatella* the gemmæ are produced very regularly from constant points on the sides of the previously existing cells, and the new cells thus produced remaining in apposition with one another, and never becoming extended into branches, constitute several concentric series on the surface of an expanded disc. In *Paludicella* they also arise with much regularity from fixed points a little below and at each side of the orifice of the previously formed cells; and here, not continuing in apposition, the new cells form branches, which, from the fixed points at which they originate, and the constant angle at which they are given off from the parent-cell, confer upon the whole colony a greater regularity than is met with in the other branched forms of the fresh-water Polyzoa.

Most of the steps in the development of the gemma may be traced with considerable facility in *Paludicella*. In the earliest condition in which I have been able to observe it, the gemma appears here as a minute tubercle, projecting from the external walls of the cell, and filled with a granular parenchyma (Pl. XI, fig. 1). It now becomes elongated (fig. 2), and we soon find it hollowed out into a cavity, which communicates with the interior of the parent-cell. The tubercle, with its cavity, increase in size, and the gemma (fig. 3) is now found to consist of an external envelope, continuous with the ectocyst of the parent-cell, and of a thick fleshy lining, continuous with the endocyst; this internal tunic has numerous large, round, nucleated cells distributed through its substance, and internally it presents an uneven surface. The two tunics of the gemma are to become the ectocyst and endocyst of the future cell.

By this time the gemma has become considerably elongated and has acquired a clavate form, and its cavity begins to be cut off from that of the parent-cell by the formation of a septum. We next perceive that a portion of the lining tunic, near the wide extremity of the gemma, projects in the form of a roundish mass into the interior of the young cell (fig. 4). It is the rudimental polypide, and we soon find in it a cavity, which is to become that of the tentacular sheath, within which, when viewed in front, may be seen an oval ring (fig. 5) which is afterwards to become the lophophore of the polypide. This ring is at first quite simple, resembling a mere fold of thickish membrane, but in a short time it presents all round a series of minute tubercles (fig. 6), the rudiments of the future tentacula. When viewed laterally (fig. 7), the lophophore in this stage is seen to be decidedly bilateral, being prolonged towards the side where the rectum is to make its appearance. The central space between the rudimental tentacula is prolonged downwards, constituting the first trace of a pharynx; and immediately below this, the mass of the polypide is hollowed out into an internal cavity, which is to become stomach and intestine. This cavity is at first filled with clear, round bodies, having a high refracting power, but in which I could not trace the double outline of a true cell-wall. The polypide is now seen to be suspended from the wall of the cell by a membranous sac. This sac is closely adherent to the polypide behind the lophophore, but upon the lophophore and tentacula it has become free, and here constitutes the tentacular sheath. Some delicate fibres, the rudiments of the retractor of the polypide, may now be plainly seen extending from just behind the lophophore to the walls of the cell. The body of the polypide at the spot directly opposite to the rudimental crown of tentacula, is also seen to be connected by a short, thick, fleshy mass, with the walls of the cell. Circular fibres may have been already seen in the lining membrane of the cell; these are chiefly collected near its proximal end (fig. 6), and are to become the parietal muscles of the adult. The body of the polypide continues to elongate itself (fig. 8), and we can soon distinguish in its cavity the three regions of œsophagus, stomach, and intestine. The rudimentary parieto-vaginal muscles may also be seen extending from the tentacular sheath to the walls of the cell; the thick, fleshy mass, by which the body of the polypide was connected with the cell-walls, has become lengthened and divided into two chords, the anterior and posterior funiculus; the tentacula continue to increase in length; the lophophore loses its bilaterality and becomes orbicular, and we now (fig. 9) find little wanting to give to the polypide and its cell the form presented by the adult.

Up to this period the young polypide has been entirely shut off from all communication with the external water, and its nutrition must have been effected through the general nutrition of the colony; now, however, an opening occurs in the new cell just over the tentacular crown of the polypide, and the last stage of development is entered on. The tentacular crown rapidly acquires its complete form, the inferior extremity of the alimentary canal becomes elongated into the great cul-de-sac of the stomach, the muscles are by this time all formed, and the polypide is capable of exsertion and retraction. It is now no longer dependent for its growth on the general nutrition of the colony, but has become an independent zooid, obtaining its food from without, and submitting it to the action of its own digestive system.

The development of the bud in the species with crescentic lophophore is essentially the same as that just described. The first appearance of the bud in *Lophopus* is seen near the orifice of the cell, as a minute spherical tubercle (Pl. XI, fig. 10), projecting from the inner surface of the endocyst into the perigastric space. It is evidently composed of a mass of minute cells with a more condensed peripheral layer. It now increases in size, and a clear, oval space becomes apparent towards one side of it (fig. 11). This space soon acquires a triangular figure (fig. 12), and it is now evident that the lophophore has begun to develop itself from its walls, and that the triangular space corresponds to the interval between the two arms of the rudimental lophophore. By this time the young polypide has become removed from the surface of the endocyst of the parent cell, to which it is now only connected by a membranous sac which suspends it in the perigastric space of the adult, and which ultimately becomes the tentacular sheath. At the same time, the alimentary canal begins to appear as a minute cavity in the part of the bud farthest removed from the walls of the cell. This cavity increases in size (figs. 13, 14), and becomes the stomach, while the intestine also shows itself as a tubular process on one side of the bud (fig. 13). The lophophore, which from its earliest appearance is distinctly bilateral, now presents the form of a semicircle, with a bilobed base, and thickened margin; as yet, there is no trace of tentacula. The retractor muscles show themselves as two fasciculi passing off from the base of the lophophore, and the funiculus may also be seen attached to the posterior extremity of the body. The tentacula now make their appearance as minute tubercles upon the thickened margin of the lophophore (fig. 15). The tentacula and arms of the lophophore are then simultaneously elongated (fig. 16), while the three regions of the alimentary canal, œsophagus, stomach, and intestine, are easily distinguishable, and little more is now wanting than an opening through the walls of the parent-cell into the tentacular sheath of the young polypide, to complete the development of the gemma.

Statoblasts.

In all the fresh-water phylactolæmatous Polyzoa, bodies of a very peculiar nature occur at certain seasons, lying loose in the perigastric space. To these bodies, for reasons to be presently mentioned, I propose to give the name of Statoblasts. From the earliest period that the fresh-water Polyzoa became an object of study, the statoblasts attracted the attention of observers. Their form is not exactly the same in the different species, but they may be generally described as lenticular bodies, varying, according to the species, from an orbicular to an elongated oval figure, and enclosed in a horny shell, which consists of two concavo-convex discs united by their margins, where they are further strengthened by a ring which runs round the entire margin, and is of a different structure from the disc (Pl. I, figs. 3—8; Pl. IV, figs. 4, 5; &c.) In *Fredericella* alone is the marginal ring so little developed as to be scarcely apparent. In all, one side would seem to be slightly more convex than the other.

In all cases, except *Cristatella* and *Pectinatella*, the statoblast is destitute of any further appendage; in these two genera, however, it is furnished, when mature, with hooked spines, which, at least in *Cristatella*, spring alternately from the two sides just within the annulus

(Pl. I, figs. 4—7), being generally more numerous and better developed on the more convex side; they thence pass outwards over the annulus, and project in short rays beyond the margin. The disc in all the species is of a deep brown colour, and would seem to be composed of a single layer of hexagonal cells, whose external walls in most cases slightly project beyond the surface of the disc, and thus give to the latter an elegantly mammillated condition. In some cases, however, the cellular condition of one or both discs is very obscure. The annulus is also composed of cells, which here occur in several layers; these cells are also for the most part larger than those of the disc and of a different colour; they are filled with air, giving to the annulus a light spongy texture, and act as a float by which the statoblast, when set free, is kept near the surface of the surrounding water.

When the statoblasts are placed under circumstances favouring their development, they open by the separation from one another of the two faces, and there then escapes from them a young polyzoon already in an advanced stage of development, and in all essential points resembling the adult individual in whose cell the statoblasts were produced (Pl. XI, figs. 42, 43).

The statoblasts have been always viewed and described as the eggs of the polyzoon in whose cell they occur, a very natural mistake, and one the more excusable as the true ovary had not yet been detected. Into this error I fell myself;* but I have now become convinced that they are a peculiar form of bud, and must on no account be confounded with genuine ova.

They are produced in the funiculus, from which they are evidently developed as buds, and may generally be seen in various stages of growth, arranged upon this chord like beads on a necklace, being younger as they approach the distal extremities of the funiculus (Pl. III, fig. 7; V, fig. 5, *s*; XI, fig. 36).

In *Lophopus*, I have succeeded in following them through various stages of their early development. Their first appearance here is in the form of a little swelling upon the funiculus, consisting of a mass of minute cells, surrounded by a denser layer, which is continuous with the surface of the funiculus. The swelling now increases in size, and assumes a more regularly oval form, while its contents appear more uniformly granular, and are plainly seen to be composed of two masses in close apposition with one another (fig. 37). We next find that the two masses have lost their distinctness, and become fused together, and the whole contents now appear to be composed of minute cells confined by an external, common, transparent membrane, which is itself manifestly cellular (fig. 38). This cellular condition of the contents must not be confounded with a true segmentation. The whole body now assumes a more lenticular form, and within the external envelope two other investments begin to show themselves. One of these (the more internal) extends over the whole surface of the cellular contents, but the other is confined to the margin of the lenticular mass which it embraces in the form of a ring (fig. 39). No manifest structure, beyond a simply granular one, can be as yet detected in either of these last-formed envelopes; but the ring is soon seen to be composed of distinct cells (fig. 40), which present a bright central nucleus-like point, and a number of concentric layers, which remind us of the secondary deposits in certain vegetable cells. Up to this point the investments are all colourless, and nearly transparent; but we now find that the internal envelope and annulus become more and more opaque, while the former assumes a deep brown colour, and the latter becomes yellow. They have both acquired a horny consistence, and the annulus is composed of large hexagonal cells filled with air. If the whole be now crushed, under the microscope, multitudes of cells will escape, all filled with minute, strongly refracting corpuscles (fig. 41, 41^{*}, 41^{**}); but any further observation of the progressive development of the contents, up to the period of the opening of the statoblast and the final escape of a young polyzoon, is henceforth, in consequence of the opacity of the covering, impossible. The statoblast has now acquired the complete form characteristic of the species, and, breaking loose from the funiculus, it falls free into the perigastric space, still surrounded by the delicate external transparent membrane, which is soon torn and disappears.

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* 'Report on Fresh-water Polyzoa.'

When exposed to conditions favorable for its further development, the two faces, after a longer or shorter period, separate from one another, as has been already said, and a young polyzoon gradually emerges and floats away freely through the surrounding water; this phenomenon I have observed in *Cristatella*, and several species of *Plumatella* (figs. 42, 43). The surface of the little polyzoon thus become free is destitute of cilia, except on the tentacula; and the motions of the young animal seem to be quite passive, except so far as they may be influenced by the ciliary action of the tentacula. At the period of its escape it possesses all the essential organization of the adult; the retractor muscles are well developed, and the polypide is capable of regular exsertion and retraction; but the endocyst is colourless and transparent, and free from the earthy particles which in the greater number of species are afterwards formed in it, and the little animal is still simple. It loses no time, however, in developing gemmæ, which soon change it to the compound form of the adult. In many cases the two separated faces of the statoblast continue for some time to adhere to the posterior end of the young polyzoon, like the valves of a bivalve shell.

In *Cristatella* the essential stages of the development of the statoblast are similar to those just described in *Lophopus*, but the external envelope acquires here over its whole surface minute cilia (Pl. I, fig. 3), and becomes separated from the rest of the statoblast by a considerable space, which is filled with semi-fluid granular contents. The statoblast acquires its full size still surrounded by the ciliated envelope, but as yet no trace of the spines is visible; these, however, shortly after show themselves growing out from the two faces of the statoblast (fig. 4); they penetrate the granular matter included within the external investment, and soon impinge on the last-mentioned membrane (fig. 5), which by this time has lost its cilia, and which now gives way, torn by the grapple-like extremities of the spines. The external and granular investments now rapidly disappear, and the statoblast presents itself as the elegant little spiny lenticular body (fig. 6) so characteristic of the genus *Cristatella*.

I have sought in vain, in all the fresh-water Polyzoa, for some orifice through which the statoblasts or ova may escape from the cells; and yet, from the large size and incompressible nature of the former, such an orifice, were it present, could hardly escape detection. Meyen,* it is true, states that he has witnessed in *Alcyonella fungosa* the escape of an egg through an opening in the vicinity of the anus; but, notwithstanding a similar observation already noticed as made by Van Beneden on the marine *Laguncula repens*, this I feel certain has been an imperfect observation of Meyen, and that the escape of the egg was the result of some accidental laceration of the tissues in this spot. There is, then, no natural aperture through which either ova or statoblasts can escape, and their liberation, I am convinced, can only take place after the destruction of the soft parts of the polyzoon has afforded to them a mode of egress through the orifice of the cell.

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* 'Naturgeschichte der Polypen,' Isis, 1828.

In two species of fresh-water Polyzoa, *Plumatella emarginata* and *Alcyonella Benedeni*, I have observed, besides the ordinary statoblasts, another kind which is characterised by some peculiarities. In both these Polyzoa the cells may be observed towards the end of summer loaded with statoblasts which lie loose within them. These are the ordinary ones, and, in the two species of Polyzoa now under consideration, are of an elongated oval figure, with a largely developed annulus which overlaps a considerable portion of the disc (Pl. IV, figs. 7—9; VII, figs. 7, 8). But, besides these bodies, others (Pl. IV, fig. 10; VII, fig. 9) may be observed which never lie loose in the cell, but are invariably attached to the internal surface of the walls, to which they adhere by means of a peculiar cement in which no trace of structure can be detected. These differ also from the unattached statoblasts in shape, being much broader in proportion to their length, while the annulus is exceedingly narrow and presents but slight traces of that highly developed cellular structure so remarkable in the others. After the decay of the cœnœcium many of these attached statoblasts may be seen adherent to the stone or other body on which the specimen had developed itself, and to which they are now connected in lines (Pl. VII, figs. 5, 10) through the medium of a portion of the old cell in which they had been produced. I am unable to state whether the origin and destination of the last-described bodies is similar to that of the others, and I have not succeeded in witnessing the escape from them of the young.

In *Alcyonella fungosa* and *Lophopus crystallinus* I have also occasionally seen bodies, which differ from the ordinary statoblasts of these Polyzoa by the possession of a regular elliptical aperture in the centre of their more convex face. They were always empty, and of their nature I have not been able to form any conclusion; they are most probably abnormal.

The general structure and development of the statoblasts being now understood, the important question at once suggests itself, what is the true import of these bodies? All that we have seen of them is manifestly in accordance with the nature of a bud. The invariable absence of germinal vesicle and germinal spot, and their never exhibiting the phenomena of yolk-cleavage, independently of the conclusive fact that true ova and ovary occur elsewhere in the same individual, are quite decisive against their being eggs. We must then look upon them as *gemmæ* peculiarly encysted and destined to remain for a period in a quiescent or pupa-like state. It was for this reason, therefore, that I proposed for them the name of *statoblasts*.*

How far the statoblasts of the Polyzoa admit of comparison with the "winter ova" of the *Rotifera* and the *ephippia* of *Daphnia* remains yet to be determined. Huxley has studied the production of "winter ova" in *Lacinularia*, and, though he has shown these bodies to be derived from a portion of the ovary, he is yet of opinion that they must be regarded as *gemmæ*.† He has carefully traced the early stages of their development in *Lacinularia*, and has shown that their contents are at one period divided into two masses. The reader will recollect that a precisely similar condition is presented by the statoblasts of the Polyzoa at an early period of their development; in the *Rotiferæ*, however, the two masses appear to continue distinct, while in the Polyzoa they are subsequently fused into a single mass. The recent researches

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[*] Στάσις, βλάστη.

[†] 'Quarterly Journal of Microscopical Science,' Oct., 1852.

of Mr. Lubbock[*] are against the supposition that the ephippia of *Daphnia* are gemmæ. He has traced the formation of the ephippial ova in the ovary as true ova; but admits at the same time that they are possibly *agamic*. The external resemblance of these ephippia with the statoblasts of the Polyzoa is singularly striking; but, with the very different origin of the two sets of bodies, we must take care not to attribute a greater share of significance to this resemblance than it really deserves.[†]

The reproductive phenomena of the fresh-water Polyzoa may be thus classed under three distinct heads:

Sexual reproduction . .	By true ova.
Non-sexual reproduction .	By gemmæ which at once proceed to the full term of their destined development.
	By statoblasts or gemmæ in which the developmental activity remains for a period latent.

In *Cristatella* and *Lophopus* I have frequently witnessed the multiplication of a colony by a process of self-division. In *Cristatella* this commences by a constriction which takes place generally towards the middle of the colony, and which gradually deepens till at last it divides the entire mass into two separate portions, which move off in opposite directions. In *Lophopus* the process is very similar; large specimens of this polyzoon have the endocyst constricted at intervals so as to give to the colony the appearance of a variously lobed body enveloped by the gelatinoid ectocyst. It is at the point of these constrictions that the self-division takes place, separating the entire colony into two or more smaller ones.

It may, perhaps, be thought that I ought to have enumerated this multiplication of colonies by a process of self-division as a fourth form of reproduction; a little consideration, however, will show that this is nothing more than a reproduction by buds, with the separation of the buds *in masses*. It is analogous to the gemmiparous reproduction of *Hydra*, and must not be confounded with the true fissiparous reproduction of the lower forms of simple animals. In the Polyzoa the colony thus extends itself by the production of gemmæ, which after development remain permanently adherent; it establishes new colonies by ova and statoblasts, and by ordinary gemmæ which ultimately become detached.

If we attempt to correlate the individual phenomena now described in connection with the reproduction of the Polyzoa, we cannot but be struck with some remarkable analogies which would seem to bring the whole process of generation and gemmation in these animals within the domain of the so-called "Law of alternation of generations." We have, first, as the immediate result of the development of the ovum, a ciliated sac-like embryo, resembling in form and habit an infusorial animalcule: it is a non-sexual zooid. From this is produced subsequently, by a process of gemmation, another form of zooid, namely, the polypide, with a much more highly differentiated structure, in which the organs of digestion especially hold a dominant position, and which we may regard as sexual or non-sexual, according to the view we take of the relation between it and the testis, as will presently be seen.

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[*] An account of the two methods of reproduction in *Daphnia*, and of the structure of the "ephippium." By John Lubbock, Esq. Abstract in 'Proc. Roy. Soc.,' Jan. 29, 1857, vol. viii.

[†] In the mode of development of the statoblasts from the funiculus of the polypide, we are involuntarily reminded of the development of the chains of salpa-buds from the stolon of the solitary salpæ.

Now, if the formation of the ovary be attended to, it will be seen that this body is developed at a late period from the walls of the original sac-like embryo, which have undergone slight changes, and have become the endocyst of the more mature Polyzoon; and it will be at once perceived that this development of the ovary takes place in a way which may obviously be compared with the formation of a bud; that at least in *Alcyonella* it occupies exactly the position in certain cells that the buds destined to become polypides do in others, and that at an early stage of polypide and ovary it is scarcely possible to distinguish one from the other; so that the idea is immediately suggested, that the body here called ovary is itself a distinct zooid, in which the whole organization becomes so completely subordinate to the reproductive function as to be entirely masked, and apparently replaced by the generative organs. This would then constitute a third zooid, which would therefore be a sexual zooid; it is, however, unisexual (female).

In the next place we find that upon the funiculus (in *Alcyonella*), which probably belongs rather to the polypide than to the endocyst, there is developed the mass here described as testis. Now, if we view this mass as a mere organ of the polypide, we must then regard the latter as the second sexual or male zooid; but the testis may perhaps be more correctly considered, like the ovary, as a distinct sexual bud, having the generative system so enormously predominant as to overrule and replace all the rest of the organization;[*] this bud, like the ovary-bud, being also unisexual, but with a male function. In confirmation of this view, it is to be remembered that the funiculus has the power of giving origin to a very remarkable form of undoubted bud, the statoblast, which, until ulterior development is excited in it, has no nearer resemblance to an ordinary polypide-bud than the testicular mass has; and to this statoblast—so far at least as position is concerned—the male bud or testis in *Alcyonella* would therefore be related just as the female bud or ovary is related to an ordinary polypide-bud. In *Paludicella* the testis, though in immediate connection with the funiculus, is developed apparently from the endocyst.

If the above be the correct view, the complete comprehension of the Polyzoon will involve the conception of a ciliated sac-like embryo as a starting point, and a series of buds, of which the last term will consist of a pair of sexual buds, the others being non-sexual; from the sexual buds a true embryo like the first is again produced, which affords the point of departure for another similar cycle.

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[*] Analogous instances of the dominant development of the generative system, so as to suppress more or less completely the development of all the other organs, occur in other members of the animal kingdom; as examples, may be mentioned the reproductive capsules (true buds) in certain *Polypi*, and the male of some of the *Rotiferæ*.

3.

Homologies of the Polyzoa.

Before commencing the zoographical portion of the present memoir, there still remains to be considered a subject of great interest to the philosophical zoologist, namely, the exact position and affinities of the Polyzoa in the animal kingdom, a question which admits of much valuable elucidation from the study of the freshwater genera.

We have seen in the historical sketch already given of the successive steps which resulted in the separation of the Polyzoa from the Polypes, that the molluscan relations of the Polyzoa began at last to be recognised in an obvious resemblance between their organization and that of the Ascideæ. Guided by this relation, an important step was finally taken by M. Milne-Edwards in distinguishing two primary series in the mollusca, characterised mainly by the relative grade of perfection of the nervous and circulatory systems. One of these, the *Molluscoida*, included the Polyzoa and Tunicata; the other, the *Mollusca proper*, embraced all the other members of the molluscan sub-kingdom. The affinities of the Tunicata and Polyzoa being thus fully recognised, it is of importance to know in what these affinities really consist; in other words, to determine the homologous organs in the two groups.

I had elsewhere[*] attempted to show what I believed to be the correct view of the relation between the Tunicata and the Polyzoa. Additional opportunities of investigation have suggested a few modifications, but after a careful comparison of all that has been urged on this subject, I am still of the opinion that in its leading points view then taken was the true one.

The great respiratory sac of the Tunicata is the most striking feature in the structure of this group, and I shall therefore first endeavour to point out where the respiratory sac of the Tunicata is represented in the Polyzoa.

Now, the opinions entertained on this subject may be classed under two distinct heads. Under the one head it is maintained that the respiratory sac of the Ascidian has its representative in the pharynx of the Polyzoon, and that the rudimentary tentacula at the orifice of this sac are homologous with the tentacula of the Polyzoon. Under the other head it is asserted that the respiratory sac of the Ascidian is homologous with the tentacular crown of the Polyzoa. I have carefully examined all that has been urged in favour of each of these views, and I believe that the evidence preponderates on the side of considering the respiratory sac of the Ascidian as truly represented by the tentacular crown of the polyzoon, though the exact nature of the homology has not been correctly stated. The reader will call to mind that the respiratory chamber of an Ascidian, consists essentially of a membranous sac, having the inner surface of its walls covered by two sets of tubular bars, one running longitudinally, or from behind forwards, the other transversely, or from the neural to the hæmal side, and thus crossing each other at right angles, while the membranous wall of the sac, in every one of the quadrangular meshes thus formed, is perforated by an aperture, (the *stigmates branchiaux* of Milne-Edwards),* surrounded by a fringe of vibratile cilia.

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[*] On the Homology of the Organs of the Tunicata and the Polyzoa. 'Transactions of the Royal Irish Academy, vol. xxii, 1852.

It must, moreover, be borne in mind, that the transverse bars open into two great longitudinal canals, the "branchial" and "thoracic sinuses" of Milne-Edwards, one placed upon the neural, and the other upon the hæmal side of the sac, that they constitute, in fact, a series of communicating channels, passing transversely between these two sinuses, receiving the blood from one and pouring it into the other.

In advocating the homology of the respiratory sac of the Ascidian with the tentacular crown of the Polyzoon, some zoologists, among whom must be especially mentioned M. Van Beneden†, maintain that the *longitudinal bars* of the sac correspond to the *tentacula* of the Polyzoon, while the *transverse bars* in the sac of the Ascidian must be considered as becoming extinct in the tentacular crown of the Polyzoon. Now this view is certainly untenable. I have in another place‡ endeavoured to show that while the respiratory sac of the Ascidian has undoubtedly its homologue in the tentacular crown of the Polyzoon, it is the *transverse* and not the longitudinal bars of this sac that are represented by the tentacula of the Polyzoon,

Fig. 6.

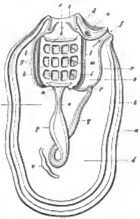

Fig. 6. Plan of an Ascidian Tunicate—longitudinal section.

Fig. 7.

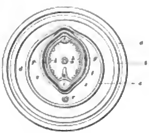

Fig. 7. Plan of an Ascidian Tunicate—transverse section.

a. External tunic. *b.* Middle tunic. *c.* Internal tunic. *d d d.* General sinus system. *e.* Respiratory orifice. *f.* Cloacal orifice. *g.* Transverse respiratory bars. *h.* Longitudinal respiratory bars. *i.* Branchial sinus. *k.* Thoracic sinus. *l l.* Proper membrane of respiratory sac. *m.* Languettes *n.* Mouth. *o.* Œsophagus. *p.* Stomach. *q.* Intestine. *r.* Anus. *s.* Cloaca. *t.* Tentacula at entrance of respiratory chamber. *u.* Ganglion. *v.* Heart.

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* See Milne-Edwards's beautiful memoir, "Sur les Ascidies Composées."

† Van Beneden sur les Ascidies simples. 'Mém. de l'Acad. Roy. de Belgique,' tome xx, 1847.

‡ 'Trans. Roy. Irish Acad., Jan. 1852.

and this is a very important distinction, which from not having been recognised, rendered previous attempts at comparison between the respiratory sac of the Ascidian and the tentacular crown of the Polyzoon indefensible.

Without a knowledge of the Hippocrepian Polyzoa, it would, perhaps, have been impossible to arrive at anything like a satisfactory conclusion on this point; the peculiarities of these Polyzoa, however, afford a key to the clearing up of this difficult subject, and we shall best perceive the relations in question by comparing an Ascidian Tunicate with a Hippocrepian Polyzoon, a *Clavelina*, for example, with a *Plumatella*, a comparison which the accompanying diagrams (figs. 6—9) will render easy.* Now it does not need much assistance from the imagination to see in the great branchial sinus of *Clavelina*, a representative of the lophophore of *Plumatella*, while the transverse bars which pass off at either side from this sinus, and are richly ciliated, will correspond to the ciliated tentacula of the Polyzoon; the delicate membrane which constitutes the proper walls of the respiratory sac, to the interior of which the respiratory bars of the Ascidian are adherent, and which is pierced in the intervals of these bars by the "branchial stigmata," will have its homologue in

Fig. 8.

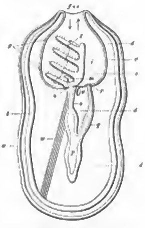

Fig. 8. Plan of a Hypocrepian Polyzoon—longitudinal section.

Fig. 9.

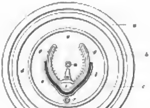

Fig. 9. Plan of a Hypocrepian Polyzoon—transverse section.

a. Ectocyst. *b.* Endocyst. *c.* Tentacular sheath. *d d d.* Perigastric space. *f + e.* Orifice of cell. *g.* Tentacula. *i.* Lophophore. *l.* Calyx. *m.* Epistome. *n.* Mouth. *o.* Œsophagus. *p.* Stomach. *q.* Intestine. *r.* Anus. *s.* Cavity of tentacular sheath. *u.* Ganglion. *w.* Retractor muscle.

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* In figs. 6—11, the same letters are used throughout to indicate homologous parts.

the calyx-like membrane adherent to the outer side of the tentacula in *Fredericella* and the Hippocrepian Polyzoa. This correspondence will be rendered more obvious by imagining the branchial sinus to be depressed towards the neural side of the Ascidian, by a rotation round its oral extremity through an angle of 90° in a vertical plane passing through the mouth and anus; its position from longitudinal will thus be changed to transverse, while the transverse bars will become longitudinal, and the branchial sinus and its bars will then have the same direction as the exserted lophophore and tentacula of *Plumatella*; while it is interesting to observe, that during the retracted state of the Polyzoon, the lophophore assumes the constant direction of the branchial sinus in the Tunicata.

That the tentacula of the Polyzoa are not homologous with the unciliated rudimental tentacula at the entrance of the respiratory sac in the Ascidiæ is apparent also, not only from the difference of structure, but from the fact, that while the tentacula of the Polyzoa are in immediate relation with the digestive tube, those of the Ascidiæ are mere appendages of the internal tunic. The real homology of the Ascidian tentacula is, in fact, to be found in the tentacular mantel-fringe of a lamellibranchiate mollusc. It is true that, in accordance with this view, we can find no homologue in the Polyzoa for the tentacula of the Ascidiæ; we must therefore conclude, that these organs have absolutely disappeared in the Polyzoa, a circumstance for which we have been already prepared by their absence in Salpa and other Tunicates.

In connection with the tentacular crown, there is another part of the organization of the Polyzoa for which we have still to find an equivalent, and which without comparison with the Tunicata would remain inexplicable, namely the *epistome* of the phylactolæmatous Polyzoa. Now for the determination of the homological import of this somewhat enigmatical organ, the key is at once afforded by the Tunicata. The epistome is plainly homologous with the tongue-like organs, the "languets" of Milne-Edwards, which are attached along the branchial sinus in *Clavelina*, and certain other Tunicates, and thence project into the cavity of the branchial sac. In Salpa, the languets are reduced to a single one; that, however, which remains in this genus is not, as we might be led to expect from the comparison we have made between these organs and the epistome of *Plumatella*, the languet nearest to the mouth, but on the contrary (if we may judge from its position), the one most remote from this part of the animal. It is, however, particularly worthy of attention, that both the existing languet of *Salpa*, and the epistome of the hippocrepian Polyzoa, are quite similarly related to the great nervous ganglion. This ganglion is certainly homologous in the Tunicata and Polyzoa, and it is manifestly it, and not the mouth, that determines the place of the persistent languet.

We now need only a few unimportant modifications in order to complete the resemblance between the branchial sac of *Clavelina* and the tentacular crown of *Plumatella*; we have only to imagine the oral extremity of the branchial sinus to be prolonged, with its bars, for a short distance towards the hæmal side, so as to surround the mouth, the transverse bars to become free at their extremities, where opposite to the branchial sinus they communicate with the "thoracic sinus," the longitudinal bars to be suppressed, and the languets to be reduced to *one*, situated in the immediate vicinity of the mouth—a series of changes involving no essential modification of structure—and we shall then have an organ only wanting in a deep crescentric depression of the distal extremity of the branchial sinus to resemble, even in minute details, the tentacular crown of *Plumatella*.

Now nearly all the changes which we have thus hypothetically supposed to take place in *Clavelina*, in order to convert its branchial sac into the tentacular crown of *Plumatella*, do actually occur in other genera of Tunicata, some in one, and some in another. The predominant importance of the transverse over the longitudinal bars of the branchial apparatus in the Tunicata is sufficiently manifest; in most cases, they are larger and more evident than the longitudinal; in *Pyrosoma*, they are not only the better developed, but they alone carry cilia. In this genus, moreover, the hæmal extremities of the transverse bars of one side are separated from the corresponding extremities of those of the other by a considerable space, and thus present a marked approach to the open condition which characterises the tentacular crown of the Polyzoa. According to Lesieur, in a species described by him, they even hang free into the branchial sac for some distance from their extremities, an important fact not easily reconcilable with the view that the branchial sac of an Ascidian is nothing more than a perforated pharynx permeated by a vascular network.

In *Doliolum*, the longitudinal bars actually disappear.

In *Salpa*, both longitudinal and transverse bars have disappeared, and the gill consists merely of a tubular rod passing obliquely across the thoracic chamber, and furnished with transverse bands of cilia. It is the homologue of the "branchial sinus" in *Clavelina*; and the mouth, situated at its posterior and hæmal end, is related to it exactly as the mouth to the "branchial sinus" in *Clavelina*. The following two diagrams will render apparent the relations of the parts in *Salpa* and *Doliolum*.

The relation of the parts in *Doliolum* is particularly interesting, and of great importance

Fig. 10.

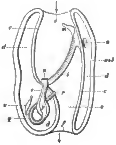

Fig. 11.

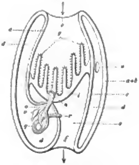

Fig. 10. Plan of *Salpa*.

Fig. 11. Plan of *Doliolum*.

a + *b*. External and middle tunic united. *c c*. Internal tunic. *d d d*. General sinus system. *e*. Respiratory orifice. *f*. Cloacal orifice. *g*. Respiratory bars. *i*. Gill (*Salpa*) and branchial sinus (*Doliolum*). *m*. Languette. *n*. Mouth. *o*. Œsophagus. *p*. Stomach. *q*. Intestine. *r*. Anus. *s*. Cloaca. *u*. Ganglion *v*. Heart.

in the determination of the present question. In this remarkable little Tunicate, the gill consists essentially of a tubular band, extending transversely across the thoracic chamber, and communicating with a series of secondary tubes, which pass off from it at each side like the leaflets of a pinnate leaf from the common petiole. The main tube, with its lateral pinnæ, thus constitutes an imperfect diaphragm, which divides the great thoracic chamber into an anterior or branchial portion, and a posterior or cloacal portion. Now the main tube may be obviously compared to the great "branchial sinus" of *Clavelina*, and the lateral branches to the transverse respiratory bars of that tunicate. The longitudinal bars have totally disappeared, and the posterior extremity of the main tube or "branchial sinus" is continued across the alimentary canal on each side, until it reaches the hæmal side of the thoracic chamber, thus causing the mouth, which perforates this tube near its centre, to be related to it and to its lateral branches, exactly as the mouth in the Polyzoa is related to the lophophore and tentacula in these. Another point of correspondence between the gill of *Doliolum* and the tentacular crown of the Polyzoa is to be found in the fact, that in *Doliolum* the "thoracic sinus" is absent, and the remote extremities of the respiratory bars of one side are quite separate from those of the other, and thus present the open condition which characterises the tentacular crown in the Polyzoa. The gill of *Doliolum* thus constitutes the exact link by which the branchial sac of the Ascidiæ passes immediately into the tentacular crown of the Polyzoa.

However interesting the *hippocrepian* Polyzoa may be in directly indicating the relations here dwelt on, the *infundibulate* genera present no difficulty, for the orbicular lophophore, after all, is but an unimportant modification of the crescentic, and is connected to it by a series of intermediate forms. The arms of the lophophore in *Plumatella* have already become obsolete in *Fredericella*, in which, however, the lophophore still retains a bilateral figure, which is rendered still more decided by the presence of the epistome. In the marine genus *Lagenella*, the epistome has disappeared, but the lophophore still retains a slight bilaterality. Finally, in the fresh-water genus *Paludicella*, and most of the marine genera, not only has the epistome disappeared, but all trace of bilaterality has now vanished from the lophophore.

A comparison of the tunics of the Tunicata with the cœnœcium of the Polyzoa will render still more obvious the relations here insisted on, and show how easily the structure of the one can be explained by the study of the other. M. Milne-Edwards has proved by the anatomy of *Clavelina* that there exist in the Tunicata three distinct envelopes, which, however, may be variously united with one another in the different genera.[*] Now all these have their homologues in the Polyzoa; the external sac or test of the Tunicata corresponds to the external investment or ectocyst of the Polyzoa; the middle sac, or "mantle," of the Tunicata to the internal investment or endocyst of the Polyzoa; and the internal or third tunic of the Tunicata, which surrounds the branchial sac, and forms the "thoracic chamber" of Milne-Edwards (and which is divided into two portions, one hæmal containing the proper branchial sac, and the other neural, constituting the cloacal chamber), will be equivalent to the tentacular sheath of the Polyzoa. The homology of the two outer tunics of the Tunicata with the ectocyst and endocyst of the Polyzoa is obvious, and need not here be further dwelt on. The homology of the third or innermost tunic of the Tunicata may perhaps, at first sight, not appear quite so manifest; it is, however, equally decided, and is a relation of great importance in the present question. If we examine this tunic in *Clavelina* (see figs. 6, 7, page 44) we shall find that it is continuous with the mantle at the respiratory and cloacal orifices, and becomes attached to the alimentary canal just behind the mouth and anus; it thus holds to the surrounding parts in the Tunicata exactly the same relation that the tentacular sheath or inverted tunic in the Polyzoa (see figs. 8, 9, page 45) does to the corresponding parts of these during the retracted state of the animal; it scarcely differs, in fact, from the tentacular sheath of the Polyzoa in anything except its being united to the branchial sac along the hæmal side, in the region of the thoracic sinus, and in its therefore not admitting of eversion. In the Polyzoa there is, properly speaking, but one external orifice, namely, that through which the tentacular crown is projected and retracted; but this is equivalent to the respiratory and cloacal orifices of the Tunicata united; and the point where the rectum opens externally in the Polyzoa is not therefore, as supposed by Van Beneden and others, the homologue of the cloacal orifice in the Tunicata with the cloacal chamber itself become extinct—a view which evidently originated in the too exclusive contemplation of the Polyzoon in its exserted state—but rather corresponds to the point where the rectum penetrates the internal tunic in the Tunicata. The cloaca of the Tunicata is nothing more than the dorsal portion of the thoracic chamber in these animals, and is plainly represented in the retracted Polyzoon by the dorsal portion of the cavity of the tentacular sheath, the whole of the cavity of this sheath becoming obliterated in the exserted state of the polypide. The thoracic chamber of the Tunicata is obviously homologous with the mantle cavity of ordinary mollusca, as has been already maintained by Huxley,[*] and the cavity of the tentacular sheath in the Polyzoa has precisely the same signification.

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[*] See Huxley, "Observations upon the Anatomy and Physiology of Salpa and Pyrosoma, together with remarks on Doliolum and Appendicularia." 'Phil. Trans.,' 1851.

The view of the homologies here taken is still further borne out by a comparison of the muscles in the two groups. Those muscles on which devolves the office of the retraction of the polypide in the Polyzoa are of course absent in the Tunicata. In the middle tunic of the Ascidiæ, however, there is, as is well known, a large development of muscular tissue in the form of circular and longitudinal fibres, which give to this tunic its characteristic contractility. Now, these muscles are exactly represented by equivalent fibres, which are developed in the homologous tunic or endocyst of the Polyzoa, and constitute the "parietal muscles" of these animals. The circular bands of Salpa and Doliolum, on the other hand, appear to be developed in the *internal* tunic, and have their representatives in the sphincters occurring in the inverted tunic, or tentacular sheath of the Polyzoa.[†]

The difference of position between the nervous ganglion in the Polyzoa and the Tunicata may seem at first to invalidate the homological views here taken, and we can easily imagine its being said, that if the branchial sac of an ascidian be homologous with the tentacular crown of a Polyzoon, in the sense here maintained, the ganglion in the Polyzoa ought to be situated, not between the œsophagus and rectum, but upon the neural edge of the lophophore. If however, we carefully consider the difference of position between the two ganglia, we shall find that it is, after all, unimportant; in the Tunicata, while the ganglion is always placed between the two external orifices, it is at the same time situated in the interval between the internal and middle tunic; it is, consequently, within the great "sinus system"* of the Tunicata, which corresponds exactly with the perigastric space of the Polyzoa. In the Polyzoa the two orifices coalescing, the ganglion can no longer occupy the position it held in the Tunicata; it is therefore carried backwards, and, still bathed in the fluid of the sinus, now becomes situated on the œsophagus, a difference of position which, it will easily be seen, involves no important change of relations, and which is necessarily connected with the difference in the arrangement of the other organs in the respective groups. In the Polyzoa, from their constant motions of retraction and exsertion, the ganglion could not occupy the fixed position which it does in the Tunicata, and therefore comes to be situated on the polypide itself, all whose motions it then necessarily follows.

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[*] 'British Association Reports,' 1852. Transactions of the Sections, p. 76.

[†] The peculiar tunicate organ called "Endostyle" by Huxley, and its accompanying ciliated furrow have no representative among the Polyzoa.

To render more complete our comparison between the Tunicata and the Polyzoa, one interesting point of difference must be here noticed, namely, that while in the Tunicata the first bend of the intestine is always, as originally insisted on by Huxley, turned towards the hæmal side,† or that opposite to the ganglion, its whole course in the Polyzoa is as invariably towards the neural or ganglionic side.

To the uniformity of plan now attempted to be demonstrated among the various members of the molluscoid series, the curious tunicate genus *Appendicularia* affords the most important exception. The singular little animals constituting this genus, which I agree with Huxley‡ and Gegenbauer§ in viewing as an independent form rather than as the larval state of an ascidian, have the thoracic chamber formed on the ascidian type, but in consequence of the non-development of a branchial sac, or of any form of gill,‖ this chamber is not divided into a branchial and cloacal portion, and has only a single external orifice. The mouth opens into it below just as in the Ascidians, but the intestine, instead of opening into any part of the thoracic chamber, runs directly to the outer walls of the sac, and terminates by perforating these walls on the ventral side. *Appendicularia*, then, cannot be viewed as forming a connecting link between the Tunicata and the Polyzoa; it is altogether anomalous, and the most important points in which it differs from the normal Tunicata are those also which separate it at the greatest distance from the Polyzoa.

A different view of the nature of the parts now under consideration has been taken by Mr. Huxley. Advocating the homology of the branchial sac of the Ascidian, not with the tentacular crown, but with the pharynx of the Polyzoon, he has brought to bear upon this view a number of important facts, and has defended it with more ingenuity than it has received from any other anatomist.*

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* This name has been given by Huxley to the whole of the space included between the internal and middle tunics in the Tunicata. It is that through which the blood unenclosed in proper vessels vaguely circulates. *Loc. cit.*

† With this generalisation, however, some recent descriptions (see Gegenbauer on *Doliolum*, in Siebold and Kölliker's 'Zeitschrift,' vol. vii, 1856) are scarcely consistent.

‡ 'Phil. Trans.,' 1851.

§ Siebold and Kolliker's 'Zeitschrift,' Band vi, 1855.

‖ Gegenbauer has shown that the thoracic chamber in *Appendicularia* is pierced just above the mouth by two ciliated apertures, from each of which he traced a tube leading into the interior of the body, but was unable to follow it to its destination. It is quite certain that these apertures are in no way homologous with the branchial stigmata of the Ascidians; it is not improbable that they form the entrance to an aquiferous system in this anomalous Tunicate.

Imagining an ideal molluscan archetype, Mr. Huxley derives from this general plan all the special modifications presented by the molluscan sub-kingdom. From this archetype he thus derives the polyzoal form. "Conceive the abdomen of the archetype to be greatly prolonged, the neural region with its appendages, the organs of sense, and the heart, remaining undeveloped, so that the anus comes into close apposition with the oral extremity, while the edges of the latter are produced into long ciliated tentacles; and the result will be a Polyzoon, which needs only the power of gemmation to give rise to those composite aggregations which are so characteristic of the group."†

In these words we have an excellent and easily comprehensible enunciation of the essential morphological characters of a Polyzoon.

In deriving the ascidian form from the archetype, "it is to be remarked," he says, "in the first place, that the pharynx, large in the Polyzoa, becomes comparatively enormous in the Ascidians; while the tentacles, which were very large in the Polyzoa, are in the Ascidians comparatively small. Next with the development of a post-abdomen, the intestine acquires a hæmal flexure; but instead of the anal aperture remaining on the hæmal side, it is bent round by the same process as in *Spirialis* and *Limacina*, but in the inverse direction. Suppose, with all this, that a mantle has been developed, and that its free margin, remaining small and narrow, has followed the anus to the neural side, while its cavity has extended up on each side of the pharynx to the middle line of the hæmal surface of the latter, carrying to a great extent a process of which the outline may be seen in *Cymbulia*, and giving rise to the atrium; —imagine also that the sac thus constituted externally by the inner surface of the mantle (third tunic) and internally by the pharynx, becomes perforated by minute apertures—and the result would be an Ascidian."‡

Now, if the above be an exact statement of the true morphology of the Ascidian, it is inconsistent with the views attempted to be demonstrated in the present paper. After a very careful consideration, however, I have not been able to adopt it. Its essential feature consists in the peculiar explanation it offers of the formation of the "atrium," the term given by Mr. Huxley to the space, including the cloaca, which intervenes between the branchial sac and the third tunic of the Ascidiæ; and it necessarily involves the supposition that the walls of this cavity wrap themselves round the pharynx in the manner of a serous sac, just as the serous lining of the pericardium in the higher animals wraps itself round the heart; and that the pharynx is therefore, properly speaking, *external* to the cavity of the atrium. I have never succeeded in satisfying myself of the reality of this condition, and must still believe that the walls of the atrium simply surround the branchial sac, without being reflected on its sides; that the branchial sac is, therefore, properly *within* the cavity of the atrium, just as the mouth and labial palps are within the mantle-cavity of the lamellibranchiate Mollusca, and the tentacular crown of the Polyzoa within the tentacular sheath during the retracted state of the polypide.

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* 'British Association Reports' for 1852, and 'English Cyclopædia,' 1855, article "Mollusca."

† Article "Mollusca" in 'English Cyclopædia, 1855, column 858.

‡ *Id.*, column 864.

From what has now been said, it will perhaps be admitted that the only homological view deducible from the comparison which we have endeavoured to institute between the two great sections of the Molluscoida, is that insisted on in the present memoir. But no view of the homological relations between two sets of organs can be accepted, unless it can also be shown that the conclusions derived from *anatomy* are confirmed by the *history of development*, or at least unless it appears that this history presents nothing irreconcileable with the conclusions which rest on anatomical evidence alone.

Unfortunately, the difficulties which beset this part of the subject render us still deficient in the class of facts here needed. We owe to Krohn[*] some of the most recent investigations into the development of the Ascidiæ, and, so far as these go, I believe them to be in accordance with the views advanced in the present memoir. In the account given by Krohn, some observations are still wanting before we can determine the exact nature and sequence of all the steps in the development of the Ascidian embryo. From this account, however, it appears that a cavity, which represents that of the future respiratory sac, shows itself at a very early period in the interior of the embryo, having immediately behind it the first indication of the alimentary canal as a tube of uniform diameter bent into a loop. The walls of this cavity are at first in close apposition with those of the thoracic chamber, which completely encloses it, so that the two cavities at this stage appear as one, being exactly co-extensive; we soon perceive, however, that the proper branchial sac becomes perforated by four apertures, the first appearance of the branchial stigmata, and at the same time becomes detached, in the region of these apertures, from the walls of the thoracic chamber, which had previously itself been perforated by the respiratory and cloacal orifices (the latter at first double, but afterwards single by coalescence). The branchial stigmata subsequently increase in number, the branchial sac at the same time detaching itself more and more from the walls of the thoracic chamber, while the space thus produced, and bounded internally by the walls of the branchial sac and externally by those of the thoracic chamber, becomes the cloacal chamber of the adult. In the intervals of the branchial stigmata, the transverse and longitudinal respiratory bars make their appearance, but the mode in which they originate is not evident; nor have we any account of the mode of formation of the branchial or thoracic sinus, the first indication of their existence being the current of blood which is seen to flow through them after the heart has begun to act. The alimentary canal, as has just been said, had already shown itself. It has now become more developed, and presents a division into the three regions of œsophagus, stomach, and intestine; while the mouth opens into the bottom of the branchial sac, and the opposite extremity is found in the cloacal chamber, or space formed by the separation from one another of the walls of the branchial sac and thoracic chamber.

We have here, then, a series of facts which admit of an easy comparison, so far as they go, with the corresponding steps in the development of the Polyzoa. It will be recollected that, in the development of the bud of a Polyzoon, a minute anterior cavity, closed on all sides, is the first evidence of differentiation. From the walls of this cavity the lophophore subsequently detaches itself, and then gives rise to the tentacles which gradually develop themselves from its margins. The cavity is here to become that of the tentacular sheath, which we have assumed as homologous with the thoracic chamber of the Ascidian; and the lophophore, which represents the thoracic sinus of the branchial sac of the Ascidian, becomes separated from it just as the branchial sac separates itself from the walls of the thoracic chamber of the Ascidian.

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[*] Krohn in Müller's 'Archiv,' 1852-3; translated in the new series of Taylor's 'Scientific Memoirs,' August, 1853.

The development of Salpa has been especially studied by Leuckart.* From the greater simplicity of the respiratory system in the Salpæ, it is easier to compare the Salpæ and Polyzoa with regard to the development of this system, than it is to institute a similar comparison between the Ascidiæ and the Polyzoa. Now, the researches of Leuckart fully bear out the views here taken. As in the Ascidians so also here does the first trace of special organs show itself in the formation of an internal closed cavity, the primary sketch of the branchial chamber. From the walls of this cavity the rod-like gill is then separated, leaving behind it a space which is to become the cloaca. The alimentary canal, about the same time, makes its appearance, and it is not until a comparatively late stage of the development that the branchial chamber communicates with the exterior by the branchial and cloacal orifices.

It is plain that, in its essential points, the resemblance here with what we have seen to occur in the Polyzoa is complete. The closed cavity, constituting the early stage of the branchial chamber in the Salpa, resembles even in minute particulars the early stage of the cavity of the tentacular sheath in the Polyzoa, as will be at once evident from an inspection of Leuckart's figures, while the rod-like gill is developed in the interior of the branchial chamber, in all essential points just as the lophophore of the Polyzoa is developed within the cavity which is ultimately to become that of the tentacular sheath in these animals. In the Polyzoa the development is continued by the shooting out from the lophophore of hollow processes which are to become the tentacula. In the Salpa these processes are never developed, and the gill continues in the condition of a polyzoal lophophore, with the tentacula suppressed.

It appears to me, then, that the points of connection attempted to be established in the present memoir between the Polyzoa and the Tunicata are those which really exist in nature; but there still remain to be considered some other relations of great interest presented by the Polyzoa. We know that the affinities of organized beings are not confined to those which directly unite them to some single allied form. On the contrary, they stream forth from them in various directions, and bring into a community of plan many different types.

Besides the close affinity between the Polyzoa and the Tunicata, another series of homologies can be pointed out, bringing the Polyzoa into intimate relation with the Brachiopoda. Mr. Hancock† had maintained the resemblance between the arms of the lophophore in the hippocrepian Polyzoa and the oral arms of the *Brachiopoda*, a resemblance singularly striking, and pointing to an important homological relation. In confirmation of this view, he has further called attention to the resemblance between the parieto-vaginal muscles of the Polyzoa and the pedicle muscles of *Terebratula*, and has compared their action, in one case in closing the orifice of the cell, in the other in closing the valves of the shell.

The resemblance between the two sets of muscles is certainly obvious, and may possibly indicate homological identity, though we should be cautious in concluding as to homological relations from mere resemblance; where functions of the same kind are to be performed, there must necessarily be a certain degree of resemblance in the instruments, and this resemblance may show itself not only in form but in position and relation to surrounding parts, though the organs themselves be fundamentally different; and it needs the light afforded by development before our conclusions as to homological identity can be considered as fully established, while our ignorance of facts connected with the embryology of the Brachiopoda deprives us of this important test in the present instance.

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* 'Zoologische Untersuchungen, Zur Anatomie und Entwickelung der Tunicata,' 1854.

† On the Anatomy of the fresh-water Bryozoa, by Albany Hancock, Esq. 'Annals and Mag. of Nat. Hist.,' 1850.

Mr. Huxley[*] has thrown still further light on the relations between the Polyzoa and Brachiopoda. He compares the relative positions and mode of articulation of the valve which closes the cell in the marine cheilostomatous Polyzoa and of the peculiar bodies known as *avicularia*, which occur in the same group of Polyzoa, with corresponding characters in the shells of the typical Brachiopoda. He shows that the smaller valve of the Brachiopod is articulated with the larger, just as the operculum of the Polyzoon is united with its cell, or as the lesser valve of an *avicularium* is articulated with the larger one; while the anus has the same relative direction in both, being in the one case turned away from the operculum of the Polyzoon, and in the other from the smaller valve of the Brachiopod. He further shows that, leaving the pedicle muscles out of consideration, the arrangement of the other muscles is exactly what occurs in an *avicularium*; "the adductors, which pass from the larger valve to be inserted into the smaller, in front of its point of support, corresponding precisely with the occlusor muscles of the *avicularium*; while the cardinal muscles which arise from the larger valve, and pass to be inserted into the cardinal process of the smaller, behind the point of support, are identical with the divaricator muscles of the *avicularium*."

The relations involved in the above views are very interesting. In order, however, to admit them, even to the extent which our ignorance of Brachiopodal embryology will admit, we must cease to look upon the *avicularium* as a mere organ in the ordinary sense of this word, and consider it as a distinct though very peculiar *zooid*, homologically repeating the structure of the ordinary zooid, a view against which no valid objections can be urged.

We thus perceive that the affinities of the Polyzoa pass off in two very evident directions —in one through the *Tunicata*, and in the other through the *Brachiopoda*; while the *Tunicata* and *Brachiopoda* conduct us by well-marked relations through the *Lamellibranchiata* into the higher *Mollusca*.

In determining the limits between the *Mollusca* and the *Molluscoida*, Huxley draws the boundary line upon the molluscan side of the *Brachiopoda*, thus including the latter in the *Molluscoida*. To this view, however, I have not been able to assent. Notwithstanding the obvious affinities just referred to between the *Brachiopoda* and the Polyzoa, I yet believe that the *Brachiopoda* are much more intimately allied to the *Lamellibranchiata* than they are to the Polyzoa.

The oral arms of the *Brachiopoda*, in which the most interesting resemblance between this group and the Polyzoa is to be found, while they are undoubtedly related to the lophophore of the latter, have just as decided a relation to the labial tentacles of the *Lamellibranchiata*, while not only in the condition of the nervous and circulatory systems, which are both upon a different plan from anything we find in the *Tunicata* or Polyzoa, but in that of the organization generally, the *Brachiopoda* possess characters which will scarcely admit of the association of these bivalves with the *Molluscoida*.*

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[*] Article "Mollusca" in 'English Cyclopædia,' 1855.

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* I cannot conclude this division of our subject without referring to a most singular little animal, whose true position is undoubtedly among the *Annelida*, but which in many points repeats the polyzoal form so exactly as to render it at first uncertain whether it be not really a hippocrepian Polyzoon that the observer has under his eyes.

I am indebted to Dr. Wright, of Edinburgh, for an opportunity of examining the little animal in question, of which he obtained two or three specimens from the coast of Devonshire, in May, 1856, and which he preserved alive for some weeks in a vessel of sea-water. Dr. Wright has published an account of it in the 'Edinburgh New Philosophical Journal' for October, 1856, where he describes it under the name of *Phoronis hippocrepia*. He also kindly placed one of his specimens at my disposal

Phoronis hippocrepia, Wright; the annelidan homomorph of the hippocrepian Polyzoa.

Fig. 12.

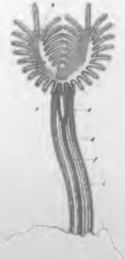

Fig. 13.

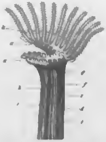

Fig. 13. View in a plane at right angles to that of fig. 12, the view of the tentaculiferous crescent is semi-ideal, the tentacula being supposed to be removed from part of its margin, in order to expose the mouth and over-arching lip.

Fig. 12. Viewed from the side of the œsophagus.

a a Tentaculiferous crescent. *b*. Mouth. *c*. Lip. *d*. Œsophagus. *e*. Intestine. *f*. Vessel conveying the blood backwards from the tentacula and crescentic disc. *g g*. The two vessels from whose union the vessel *f* results. *h*. Vessel conveying the blood forwards towards the crescentic disc and tentacula. *i i*. Longitudinal muscular fibres in stem.

ZOOGRAPHY.

1.

History and Bibliography.

We have already seen that in the year 1741, Trembley discovered his "Polype à Panache." This is the first recorded discovery of a fresh-water Polyzoon. Trembley communicated his discovery to Reaumur and Bernard de Jussieu; and these celebrated naturalists detected the statoblasts, which they took for eggs, and observed the escape from them of the young Polyzoon.

In 1744, Trembley published his famous memoirs on fresh-water polypes.* In these is a full description of the "Polype à Panache," accompanied with two figures; the description is wonderfully accurate, and the anatomical details have been in few points surpassed by subse-

for examination, and I have been thus enabled to make the annexed drawing, which represents accurately the structure so far as it was possible to determine it from the single specimen examined.

The animal inhabited a fissure in a fragment of rock, from which it was capable of being protruded to the length of about two lines, and into which it would again suddenly withdraw on the least annoyance. When fully protruded, it presented the form of a cylindrical stem, totally destitute of annulation, and bearing upon its summit a crescentic disc, margined with tentacula. This tentaculiferous disc exactly resembled the lophophore and tentacula of a hippocrepian Polyzoon. In the body of the crescentic disc was placed the mouth, over which there arched a valve-like lip, situated exactly as the epistome of a Polyzoon. The mouth led into an œsophagus which could be easily traced backwards within the perfectly transparent walls of the stem, until it was lost in the piece of rock which concealed the posterior part of the animal. Parallel to the œsophagus, and on the side corresponding to the concavity of the crescent, the rectum was seen passing forwards to open by a distinct anus, in the bottom of this concavity, just beside the mouth. Round the entire margin of the crescent was borne, in uninterrupted succession, a series of ciliated tentacula, surrounded at their base by a membrane resembling the calyx of a phylactolæmatous Polyzoon.

So far the structure is absolutely undistinguishable from that of a hippocrepian Polyzoon, which it resembles even in minute and apparently non-essential details; but when we come to examine the rest of the organization, we find that the polyzoal type is widely departed from. On the rectal side of the animal may be seen passing from behind forwards, and in close relation with the intestine, a very distinct pulsating vessel, which carries a stream of red corpusculated blood into the cavity of the crescentic disc. From this the blood passes into all the tentacles, and may be seen as a continuous stream flowing towards their extremities. When it arrives there, it takes a retrograde course, flowing back again through the same channel into the cavity of the disc. We now find that the returning blood has entered another great vessel, which lies upon the œsophagus, and is formed by the union of two branches, one from each arm of the crescent, which embrace the œsophagus just behind the mouth. Through this vessel the blood flows backwards in a continuous stream. The great afferent and efferent trunks, now described, were traced so far back as the fissure in which the little animal was lodged, where the concealment of the parts rendered it impossible to follow them further. In the efferent quent observers. Trembley has demonstrated a complete alimentary canal, consisting of œsophagus, stomach, and intestine; but though he has seen the emission of the excrementitial matter from the intestine, the actual termination of this tube has escaped him. He has observed the retractor muscles, and has noticed the *funiculus* attached to the fundus of the stomach; this last organ, however, he supposes to be a muscle destined, like the true retractors, for the withdrawal of the polypide into its cell. He has shown the connection between the polypide and its cell, and demonstrated that the former ought not to be viewed as the mere fabricator of the latter, as the caddis worm is of his case, but that each is an inseparable part of one and the same animal. He witnessed also the circulation of the fluid in the perigastric space. This circulation was rendered evident by the presence of small spherical bodies, which were kept in continual motion, and were often propelled from one cell into a neighbouring one; a fact which at once led him to infer the continuity of the cavities of the different cells. These corpuscles he suspected, but without sufficient grounds, to be the eggs of his polype. We find that, in a letter addressed to Bonnet, and quoted by this philosopher in his 'Considérations sur les Corps Organisés,'* Trembley describes with great accuracy the statoblasts of a fresh-water

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* Trembley, 'Mémoires pour servir à l'Histoire d'un genre de Polypes d'eau douce.' Leyde, 1744.

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vessel the current of blood was intermittent. Immediately on being emptied, the whole of the visible portion of the vessel contracted vigorously, and then slowly expanded for the reception of a fresh influx of blood, the pulses being at very regular intervals. No reversed action could be observed in the pulsation of this vessel, though, as already mentioned, the current of blood in the tentacula was alternately direct and inverse. In the efferent vessel there was no pulsation, and the current was here perfectly continuous. The circulation in the interior of the crescentic disc appears to be properly extra-vascular, and the cavity of this disc must be viewed as a great sinus.

Another important point of departure from polyzoal structure is found in the absence of a proper perigastric space, the alimentary canal and vessels being fixed in the stem, and embraced by its walls, so as to leave little or no intervening space, while the perigastric fluid is here replaced by the true blood in its proper vessels. There is, therefore, no power of invagination, and retraction is probably as not entirely similar to that by which the ordinary tubicolous Annelides are withdrawn into their tubes. Well-marked longitudinal, muscular (?) fibres are visible in the stem.

The nervous system was not detected; and, as it was impossible to expose the posterior part of the animal without running the risk of its entire destruction, much of its organization still remains altogether unknown.

As to the true relations of the little animal now described, it appears to me that they are to be found with the Annelides rather than with any other group of the animal kingdom, and, notwithstanding the singular resemblance in certain parts of its structure between it and a hippocrepian Polyzoon, I believe that this resemblance points to no real affinity, and must be viewed only as a remarkable example of representative form,—of isomorphism as distinguished both from homology and analogy,—of which the resemblance between the Polyzoa and the Polypes affords another, and which is paralleled in the vegetable kingdom by such instances as that presented by the repetition of the Cactus form in the African Euphorbiæ.

The above account was drawn up and in the printer's hands before I had read Dr Wright's description, from which it slightly differs in one or two particulars, but in none which can render nugatory the special point which has caused its introduction here, namely, the remarkable and highly instructive example afforded by it of the assumption of polyzoal form by a widely different type of organization, without this identity of form in any way indicating a relation of homology.

* Bonnet, 'Considérations sur les Corps Organisés.' Amst., 1762.

Polyzoon of a different species from the "Polype à Panache," and probably a *Plumatella*. He informs us that he obtained them in England in 1745, and that, after having preserved them for many months in a dry state, they produced young polypes on being placed in water. He naturally considered these statoblasts as eggs.

In the 'Transactions of the Royal Academy of Sciences of Stockholm, for the year 1746, is a memoir on fresh-water polypes, by Bæck.[*] In this memoir two kinds of Polyzoa are described; one is the "Polype à Panache" of Trembley, whose figures he reproduces; the other is probably *Alcyonella*.

In Baker's 'Employment for the Microscope,' published in 1753,[†] we have, under the name of "The Bellflower Animal," the description of a Polyzoon which would seem to be identical with the "Polype à Panache." Baker is an accurate observer and a faithful recorder of what he has witnessed. The structure of his "Bellflower Animal" is described with much fulness; like Trembley, he has recognised a complete digestive canal, and has even gone further than the celebrated historian of the 'Polypes d'Eau douce,' in detecting the termination of the intestine.

In 1754, Schäffer published a memoir on the fresh-water polypes of the neighbourhood of Regensburg.[‡] In this memoir he describes and figures, under the name of "Kammpolyp," a Polyzoon composed of branched tubes, which extend themselves over the surface of submerged stems and leaves. There would seem to be little doubt of Schäffer's animal being the true *Plumatella repens* of succeeding authors.

In 1755, Rösel published the first volume of the Supplement to his 'Insecten-Belustigungen.'[§] We have here a history of the fresh-water Polyzoa which had come under his own observation. Under the name of "der Federbusch-polyp," he describes the *Plumatella repens;* his specimens mostly belonged to the *free* variation of this Polyzoon, while Schäffer seems to have had in view the *attached* form. In his account of the internal structure, though he had the advantage of Trembley's and Baker's observations on the "Polype à Panache," he falls far behind these naturalists in accuracy. He observed the statoblasts in the interior of the tubes, and, under the impression that he had recognised similar bodies on the under surface of the floating fronds of Lemna, he believes them to be the seeds of this plant, and supposes what he had seen in the interior of the tube to be some of these seeds which the Polyzoon had swallowed. This belief had so taken possession of him, that, plainly seeing the statoblasts external to what Trembley had already described as the alimentary canal, he is forced to deny the accuracy of Trembley's account of the œsophagus, stomach, and intestine of the "Polype à Panache;" and though he has seen, and expressed in his figures the expulsion of the fæcal matter, and even, though imperfectly, represented the alimentary canal, he cannot bring himself to recognise in this tube its proper function. The fæces, moreover, are incorrectly figured as escaping at the side of the plume, opposite to the rectum. His description and figures of the external characters are tolerably good, with the exception of what he says of a kind of collar, which he compares to the iron ferule on the handle of an awl, and represents as surrounding the orifices of the tubes. Rösel has here evidently seen the tentacular sheath in a semi-everted state, in which it presents somewhat the appearance he has described; and believing this to be a permanent character of his polype, has been thus led into error. He has witnessed the currents caused by the tentacular cilia, but has attributed them to water expelled from the mouth.

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[*] Bæck, 'Berättelse om Watten Polypen, i anledning af dem som äro fundne omkring Stockholm.' Acta Holm., vii.

[†] Baker, 'Employment for the Microscope.' London, 1753.

[‡] J. Chr. Schaeffer, 'Die Armpolypen in den süssen Wasser um Regensburg entdeckt und beschrieben.' Regensburg, 1754.

[§] Rösel, 'Insecten-Belustigungen.' Nürnb., 1746—1761.

A discovery by Rösel of much interest was that of certain little roundish bodies, about the size of the head of a pin, and of a yellowish colour, which, in the month of May, 1754, he found in the water of a neighbouring pond, and which, on being allowed to rest, emitted from various parts of their surface little plumes like those of his "Federbusch-polyp." Rösel has described these little bodies under the title of "Der Kleinere Federbusch-polyp mit dem ballenförmigen Körper." They are the young condition of the Polyzoon, for which Cuvier afterwards constituted a new genus, under the name of *Cristatella*.

Linnæus's grand invention of a binary nomenclature had now been established, and we accordingly find in the tenth edition of the 'Systema Naturæ,' published in 1758, the fresh-water Polyzoa for the first time designated by a generic and specific name.* The "Federbusch-polyp" of Rösel is here described under the title of *Tubipora repens*, but with Bæck erroneously referred to among the synonyms. In the 'Fauna Suecica,' 1761, we find the same animal mentioned under the same name.†

In 1766, Pallas published his 'Elenchus Zoophytorum.'‡ In this work we have the fresh-water Polyzoa described under generic and specific names, in accordance with the example already set by Linnæus. Under the genus *Tubularia*, Pallas includes two fresh-water Polyzoa; one is the "Polype à Panache" of Trembley, which is now described by Pallas under the name of *Tubularia crystallina*; the other, the "Federbusch-polyp" of Rösel, described under that of *Tubularia gelatinosa*.

In the year 1768, Pallas presented to the Royal Academy of Sciences of St. Petersburg, a memoir on a peculiar production which he had discovered in a lake connected with the River Kliasma, near Vlademir, in Russia.§ It was in the form of large fungoid or spongy masses, and was composed of multitudes of closely compacted tubes, each of which opened upon the surface of the mass by a pentagonal or hexagonal orifice, which allowed of the exsertion of a polypoid body in all respects resembling those of Trembley and Rösel. To his newly discovered animal, Pallas gave the name of *Tubularia fungosa*; it is identical with that subsequently named *Alcyonella stagnorum* by Lamarck. The memoir is illustrated by a plate exhibiting the external characters of the Polyzoon, and a magnified but not very correct view of the tentacular crown, and, though quite destitute of anatomical detail, must yet be viewed as an important contribution to the zoology of the day.

Leendert Bomme, of Flissingen, in 1769, described the tentacular currents in certain marine Polyzoa, and detected the cilia by whose action these currents were produced;[*] he observed similar currents, and the cilia causing them, in some fresh-water Polyzoa which he found in the Isle of Walcheren.

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* Linnæus, 'Systema Naturæ,' editio decima. Holmiæ, 1758, vol. i, p. 790.

† Linnæus, 'Fauna Suecica.' Stockholmiæ, 1761, p. 537.

‡ Pallas, 'Elenchus Zoophytorum.' Hagæ-Comitum, 1766.

§ Pallas, Descriptio Tubulariæ fungosæ prope Volodemirum observatæ. 'Nov. Comm. Petr.,' xii, p. 565.

We have seen that Trembley ascribed the currents in question to the motion of the tentacula, while Rösel, on the other hand, attributed them to the water ejected from the mouth. Leendert Bomme has the credit of referring them to the true cause; while in this discovery he has effected an important extension of our acquaintance with vibratile cilia, organs which had previously not been known beyond the *Infusoria* and *Rotifera*, and which have since been recognised as so very widely distributed, and so intimately connected with some of the most important functions of living beings.

In the 'Vermium terrestrium et fluviatilium Historia,' published in 1773,[†] Müller institutes the name of *Tubularia repens* for the "Kammpolyp" of Schäffer, which he considers specifically distinct from the "Federbusch-polyp" of Rösel, chiefly on the grounds of its being deprived of the *collar*, which, as we have already seen, Rösel has erroneously attributed to his animal.

Müller has distinctly traced with Trembley and Baker an œsophagus, stomach, and intestines, and has pointed out the error of Rösel regarding the statoblasts, which this naturalist mistook for the seeds of Lemna.

In September, 1774, Blumenbach described, at a meeting of the Royal Society of Göttingen, a new fresh-water Polyzoon, which he had discovered in the neighbourhood of that town.[‡] He names it *Tubularia sultana*, and gives a figure of it in his 'Manual of Natural History,' published in 1779.[§] It is at once distinguished from all previously described fresh-water Polyzoa by the tentacula being disposed in a circle, instead of presenting the form of a crescent, by which the others are all characterised. Blumenbach's *Tubularia sultana* is the Polyzoon afterwards discovered by Gervase at Plessis-Piquet, near Paris, and for which this naturalist found it necessary to constitute a new genus under the name of *Fredericella*. Blumenbach characterises it in his manual as "Tubularia crista infundibuliformi, ad basin ciliata;" the latter part of this diagnosis can scarcely refer to the true vibratile cilia which clothe the tentacula in their entire length, and is apparently framed from an imperfect observation of the caliciform membrane with which the base of the plume is furnished, and whose deeply festooned margin may have suggested the character "ciliata."

In 1776, Eichhorn published his 'Beiträge zur Naturgeschichte der Kleinsten Wasserthiere.'[‖] In this we have a description with figures of a fresh-water Polyzoon, which he calls "Der Polyp mit dem Feder-busch." Eichhorn's animal would seem to be the attached form of *Plumatella repens*, and identical with Schäffer's. He represents a specimen extending over an aquatic stem, and gives a tolerably good view of the expanded plume. He describes and figures the tentacular cilia. He tells us that each tentacle is furnished on the extremity with a depression, which he compares to the nail of the finger. This, however, is evidently the result of an erroneous interpretation of the appearance presented when the curved extremity of the tentacle is turned towards the eye of the observer and fore-shortened. So impressed, however, is he with the resemblance of the tentacle to a finger, that he says the animal may be called "Das Finger-thier," and he is in great delight at seeing one of the supposed fingers when separated from the plume swimming about with an apparently spontaneous motion.

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[*] LEENDERT BOMME, 'Bericht aangaande verscheiden zonderlinge Zee-Insecten.' Acta Vliss., 1769.

[†] MÜLLER, 'Vermium terrestrium et fluviatilium Historia.' Lips., 1773.

[‡] BLUMENBACH, Von den Federbusch-polypen in den Göttingeschen Gewässern. 'Göttin. Mag.,' i, p. 117.

[§] BLUMENBACH, 'Handbuch der Naturgeschichte.' Göttingen, 1779.

[‖] EICHHORN, 'Beiträge zur Naturgeschichte der kleinsten Wasserthiere in den Gewässern und um Danzig.' Danz., 1776.

Dumortier and Van Beneden inform us* that Schmiedel, in his 'Icones plantarum,' describes and figures, under the name of *Spongia lacustris*, the *Alcyonella* in the condition in which it is found in the autumn after the soft parts have disappeared. The 'Icones plantarum' was published in 1782. I have not succeeded in procuring it.

In 1786, was published the 'Animalcula Infusoria'† of Müller. In this work is described, under the name of *Leucophra heteroclita*, a minute animal of whose identity with the ciliated embryo of *Alcyonella fungosa*, as subsequently pointed out by Meyen, or more probably with that of *Plumatella repens*, there can be now no doubt. Muller's description is accompanied by figures, very good considering the imperfect construction of the microscopes then available.

In 1789, we find Bruguière, in the 'Encyclopédie Methodique,' describing, under the name of *Alcyonium fluviatile*, a production sent to him by M. Dantic, who found it in the waters of the fountain of Bagnolet, near Paris.‡ Bruguière was evidently unacquainted with the memoir of Pallas, but his account leaves us in no doubt of the identity of his *Alcyonium fluviatile* with the *Tubularia fungosa* of this naturalist. His figure, however, is singularly incorrect; he represents the animal with a variable number of attenuated filiform tentacula, each terminated by a spherical capitulum, and the whole springing from about seven eighths of the circumference of a circular disc. In his location of the Polyzoon among the *Alcyoniums*, he errs too, as much as Pallas did when he made it a species of *Tubularia*.

In 1797, Lichtenstein, believing that he had witnessed certain Polyzoa escaping from the little spherical capsules which occur imbedded in the base of *Spongilla*, maintained, in a communication to the Natural History Society of Copenhagen, that the fresh-water sponge consisted only of the cells of these Polyzoa after having been abandoned by the polypides;§ an opinion which could only have arisen from some very confused observations, and probably from his having mistaken a dead *Alcyonella* for a *Spongilla*. He further maintains that all the forms of fresh-water Polyzoa then known are only variations of one and the same species.

Hitherto, no step of importance had been made towards the scientific classification of the fresh-water Polyzoa. The invention by Linnæus of a binary nomenclature, had, it is true, prepared the way for a systematic arrangement; but, as yet, the Polyzoa of fresh water had been placed in the same genera with marine forms of a totally different organisation, while some of them had not been accurately distinguished from one another.

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* Dumortier et Van Beneden, Hist. Nat. des Polypes Comp. d'eau douce. 'Nouveaux Mémoires de l'Acad.-Roy. de Bruxelles,' tome xvi, 1843.

† Otho Fridericus Müller, 'Animalcula Infusoria Fluviatilia et Marina.' Hauniæ, 1786.

‡ Bruguière, 'Encycl. Méthod.' Vers, p. 24.

§ Lichtenstein, 'Skrivter af Naturhistorie Selskabet,' p. 104. Kjobenhavn, 1797.

At length, Cuvier, in his 'Tableau élémentaire des Animaux,'* struck by the distinctive characters of the little Polyzoon described by Rösel, under the name of "Der Kleinere Federbusch-polyp mit dem ballen-förmigen Körper," assumed it as the type of a new genus, to which he gave the name of *Cristatella*. The other fresh-water Polyzoa he allowed to remain in the genera in which his predecessors had placed them, and even with regard to his *Cristatella*, though he acknowledge its affinity with the other fresh-water Polyzoa, he was ignorant of its true relations, for he kept it in the vicinity of the infusorial *Vorticellæ*.

In the year 1804, Vaucher published, in the 'Bulletin de la Société Philomathique,' a short description of two Polyzoa, one of which he believes to be the animal described by Schäffer (*Tubularia repens*, Müller); the other a new species to which he gives the name of *Tubularia lucifuga*.† Vaucher's memoir is accompanied by figures of both species, but the description is so meager, and the figures so defective, that it is impossible to determine the species intended.

The memoir of Vaucher was followed by a most important reform. Bosc, already convinced, that the so-called *Tubularias* of fresh water were incorrectly associated with the marine group of this name,‡ now constituted for their reception a distinct genus, whose characters he gave in the same number of the 'Bulletin' as that which contained Vaucher's memoir. The following are the characters on which Bosc founded his new genus:

"Polypier fixé à tige grêle, membraneux, souvent ramifié, terminé, ainsi que ses rameaux par un polype dont le corps peut entrer entièrement dans la tige, et dont la bouche est entourée d'un seul rang de tentacules ciliés."

Bosc, however, though he defined the genus, neglected to name it, and his views received but little attention till Lamarck, in his 'Histoire des Animaux sans Vertèbres,' published in 1816, gave the name of *Plumatella* to the genus defined by Bosc; while, for the *Alcyonium fluviatile* of Bruguière, he constituted a new genus under the name of *Alcyonella*. In his definition of the genus *Alcyonella*, Lamarck has evidently been led into error by the description and figures of Bruguière, for the celebrated author of the 'History of Invertebrate Animals,' though he had seen recent specimens, seems to have examined them very imperfectly, and to have taken for granted the correctness of the account in the 'Encyclopédie.' He describes the polypes as "elongati cylindrici; tentaculis circa orem 15 ad 20, erectis, fasciculum turbinatum vel infundibuliformem uno latere imperfectum componentibus." To Lamarck, however, notwithstanding the erroneous characters in this definition, is due the credit of having been the first to distribute the fresh-water Polyzoa under three distinct and peculiar genera, namely, *Cristatella*, *Alcyonella*, and *Plumatella*, a most important step towards the further elucidation of the tribe. Lamarck associates *Cristatella* and *Alcyonella* with *Difflugia*, a Rhizopod previously described by M. Leclerc, and with *Spongilla*, to constitute, under the name of "*Polypiers fluviatiles*," the first section of his "*Polypes à Polypier*;"

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* Cuvier, 'Tableau élémentaire de l'histoire naturelle des Animaux.' Paris, 1798.

† Vaucher, Observations sur les Tubulaires d'eau douce. 'Bull. Soc. Philom.,' 1804, p. 157.

‡ Bosc, 'Histoire Naturelle des Vers.'

while *Plumatella* is united with *Tubularia* and *Cellaria*, and many other marine Hydrozoa and Polyzoa, to form, under the name of "*Polypiers vaginiformes*," the second section of the same order. Lamarck enumerates four species of *Plumatella*, namely, *P. cristata* = "Polype à Panache," Trembley; *P. campanulata* = "Federbusch-polyp," Rösel; *P. repens* = Kamm-polyp," Schäffer; and *P. lucifuga*, Vaucher.

The specific name of *fluviatile* given by Bruguière to the only species of the genus *Alcyonella*, at that time known, was changed by Lamarck into *stagnarum*, a name certainly more in conformity with the habits of the animal, but one far less expressive than the original name of *fungosa* given by Pallas, a name which, independently of its appropriateness, ought, in accordance with the rules of priority, and in justice to the memory of Pallas, to be still preserved.

In his 'Histoire des Polypiers,'[*] published in 1816, Lamouroux changes Lamarck's name of *Plumatella* into that of *Naisa*, a change entirely uncalled for, and founded on erroneous views of the structure of the genus; and though Lamouroux retains the name of *Naisa* in his 'Exposition Méthodique,'[†] published in 1821, Deslongchamps is the only other naturalist I can find who has thought it necessary to adopt it.[‡]

With the exception of the observations made by Trembley on his "Polype à Panache," when he described a complete alimentary canal and retractor muscles, those by Baker, who gives an exceedingly correct account of the digestive tube in his "Bell-flower animal," and those by Müller, who correctly describes the same parts in his *Tubularia repens*, though he has left us no figure, we find, up to the period of which we now write, no remark of any value on the internal structure of the fresh-water Polyzoa. In the year 1828, however, the attention of naturalists was called to the structure of these animals in a most elaborate memoir published by Raspail, under the title of 'Histoire Naturelle de l'Alcyonella fluviatile.'[§]

Raspail had, a short time before, in conjunction with M. Robineau Desvoidy, presented to the Academy of Sciences at Paris, a memoir on the same animal. This memoir, for a knowledge of which we are solely indebted to Cuvier's report[‖]—for it was never published—contains a most erroneous view of the subject, and maintains that the so-called polypes have no necessary connection with the sponge-like mass of the *Alcyonella*, and are merely accidental occupants of the cells.

In the second memoir, however, the author entirely abandons his former opinion. This memoir is characterised by much originality, and, like most of the writings of Raspail, is marked by a complete freedom from the restraints which the authority of previous investigators so generally imposes. Many of his observations, however, are evidently made with inferior instruments, and the memoir is full of hasty generalisations, which the author builds on a far too limited number of facts. Raspail has detected the mouth and anus of *Alcyonella*; but though he has had the advantage of the previous observations of Trembley, Baker, and Muller,

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[*] Lamouroux, 'Histoire des Polypiers Coralligènes flexibles.' Caen, 1816

[†] Lamouroux, 'Exposition Méthodique des genres de l'ordre des Polypiers.' Paris, 1821.

[‡] Deslongchamps, 'Encyclopédie Méthodique, Zoophytes,' 1824.

[§] Raspail, Histoire Naturelle de l'Alcyonelle fluviatile et des genres voisins. 'Mém. de la Soc d'Hist. Nat. de Paris,' iv, 1828.

[‖] Cuvier, 'Hist. des progrès des Sci. Nat.,' tome ii on closely allied Polyzoa, he has fallen far short of these naturalists in tracing the intermediate course of the alimentary canal. His ideas on this part of the structure seem to correspond very closely with those of Rösel, and he joins with this naturalist in denying the accuracy of Trembley's description of the digestive organs of the "Polype à Panache." He does not admit the existence of distinct muscles, and maintains that Trembley erroneously ascribed retractor muscles to his "Polype à Panache," asserting that he has mistaken for them the inverted tentacular sheath. Here also, Raspail, in denying the conclusions of Trembley, departs from truth; the celebrated discoverer of the "Polype à Panache" made no such mistake as that attributed to him by Raspail; and though, as we have already seen, he erroneously ascribed to the funiculus the function of a muscle, he interpreted truly as retractor muscles the appearance which Raspail referred to the inverted sheath of the tentacula. Raspail did not allow the cilia with which the tentacula are clothed to escape him, though he strangely refers the phenomena of ciliary motion, here as well as in other cases of its occurrence, to a deceptive appearance occasioned by certain alterations in the density of the surrounding fluid attendant on the act of respiration; an error which we can scarcely otherwise explain than by supposing it to result from the use of a microscope of very inferior powers. He has seen the funiculus which Trembley mistook for a muscle, and attributes to it the function of an ovary; and he has examined the external form of the statoblasts, which he considers to be eggs, and the structure of their investing capsule, with more detail than any previous observer.

But the most singular feature in the memoir is to be found in its zoological, rather than its anatomical bearing, for the author refers all the fresh-water Polyzoa to a single species, believing them to be merely different stages of development and non-essential variations of his "Alcyonelle fluviatile;" an opinion which is not very far separated from that of Lichtenstein, already mentioned. The doctrines of Lichtenstein and Raspail, however, made but little way; and it seems, indeed, only necessary to compare the various forms of fresh-water Polyzoa with one another, to be convinced of the entire groundlessness of their positions. Raspail's memoir, upon the whole, though a most elaborate one, and copiously illustrated with well-executed plates, tells us very little of importance, and must, in many respects, be viewed as a retrograde step in this department of zoology.

In the same year with the appearance of Raspail's memoir, Meyen published, in the 'Isis,' a paper on *Alcyonella*.[*] He improves, in some important points, Lamarck's definition of the genus, though he retains the incorrect character which ascribes to the animal but twenty or thirty tentacula. He enters also into some anatomical details, but in these we find little new, while they are by no means free from error. He figures more accurately than any other author since the time of Trembley and Baker, the complete course of the alimentary canal, but he mistakes the rectum for the stomach. The chief value, however, of Meyen's memoir is to be found in the announcement of the very important fact, that the *Alcyonella* produces locomotive ciliated embryos; he figures these, and describes them at length, but his account is in some points incorrect. Raspail, in the memoir already referred to, maintains that the *Leucophra heteroclyta*, described long since by Müller as an infusorial animalcule, is only a young state of his *Alcyonella fluviatilis*; and Meyen now confirms the opinion of Raspail, and shows

[*] Meyen, Naturgeschichte der Polypen. 'Isis,' 1828.

that Müller's animalcule is really the ciliated embryo of *Alcyonella*. He admits his inability to determine the nature of the brown egg-like bodies found in the interior of the tubes, and denies to them the office of eggs. In a subsequent note by the same author, published in the 'Isis,' 1830,* he ventures the opinion that the *Tubularia sultana* of Blumenbach is only the *Difflugia proteiformis*, a minute Rhizopod now well known, and originally described by M. Leclerc, in a memoir presented nearly forty years previously to the Institut.†

In a still later memoir,‡ Meyen informs us that Nordmann has seen crustacea escape from the statoblasts of *Alcyonella*; and relying on this certainly erroneous observation, he concludes that the statoblasts of *Alcyonella* and *Cristatella* are nothing more than parasites peculiar to these genera.

In 1828, Dr. Fleming published his 'History of British Animals.'§ In this work he enumerates under the genus *Plumatella* two species, *P. repens* and *P. gelatinosa*, as inhabiting the fresh waters of Scotland. His *P. repens* is undoubtedly the true *P. repens*, but his *P. gelatinosa* is *Fredericella sultana*. Dr. Fleming has traced the entire course of the alimentary canal, and has recognised in these animals the true polyzoal type of structure.

Ehrenberg, in his 'Symbolæ Physicæ,' 1831, defines the genus *Alcyonella*,‖ but this definition embraces the different species of *Plumatella*, as well as a new Polyzoon which he had discovered in the neighbourhood of Berlin, but which he must have observed very imperfectly, for its structure is so peculiar as to place it even in a family distinct from that of *Alcyonella*, with which he associates it, under the name of *Alcyonella articulata*. Gervais, who subsequently found it at Plessis-Piquet, near Paris, saw the necessity of characterising it as the type of a new genus, to which he gave the name of *Paludicella*.¶ In 1837, Mr. William Thompson, of Belfast, discovered this interesting Polyzoon in Lough Erne, in the county of Fermanagh; and it has since been found in abundance in other localities in the British Islands, and on the Continent.

At the meeting of the British Association for the Advancement of Science, held at Edinburgh, in 1834, Sir John Graham Dalyell** describes, under the names of *Cristatella mirabilis* and *C. paludosa*, two species of Polyzoa as occurring in the fresh waters of Scotland. His *C. mirabilis* is undoubtedly the *C. mucedo* of Cuvier, while his *C. paludosa* is certainly not a *Cristatella* at all; and from the description contained in the report of his paper, it is impossible to identify the animal so designated. He gives, on the whole, a very good description of his *Cristatella mirabilis*. He has observed the epistome, and accurately describes the statoblasts, which he has seen to open for the escape of the young.

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* Meyen, Nachträgliche Bemerkungen zur Naturg. der Polypen des süssen Wassers. 'Isis,' 1830.

† Leclerc, Sur la Difflugia, nouveau genre de Polype amorphe. 'Mém. du Muséum,' tome ii, p. 474.

‡ Meyen, Beiträge zur Zoologie gesammelt auf einer Reise um die Erde, p. 160. 'Nov. Act. Nat. Cur.,' 1834.

§ Fleming, 'A History of British Animals, exhibiting their descriptive characters.' Edinburgh, 1828.

‖ Ehrenberg, 'Symbolæ Physicæ; seu icones et descriptiones animalium,' &c. Berol., 1828—1831.

¶ Gervais, Recherches sur les Polypes d'eau douce des genres *Plumatella*, *Cristatella*, et *Paludicella*. 'Ann. Sc. Nat.,' 2e sér., vii, p. 74.

** Dalyell, On the propagation of certain Scottish Zoophytes. 'Rep. Brit. Assoc.,' 1834.

In 1834, M. De Blainville published the first edition of his 'Manual of Actinology.'[*] In this he constitutes a distinct sub-class of his Polypiaires, under the name of *Polypiaria dubia* for such as have the tentacula borne upon two diverging arms, in the form of a horse-shoe. It includes the fresh-water genera then known, namely, *Cristatella*, *Plumatella*, and *Alcyonella*, together with the *Difflugia* of Leclerc—an animal in no way related to them—and the marine genus *Dedalæa*, established by Quoy and Gaimard[†] for a very singular animal discovered by these naturalists in the seas of the Mauritius, and with which we are but very imperfectly acquainted. De Blainville's location of the *Dedalæa* in his *Polypiaria dubia* is founded on the examination of a specimen brought home by Quoy and Gaimard, and preserved in spirits, and the genus is certainly incorrectly associated with the fresh-water forms. In subsequent editions of his 'Manual,' M. De Blainville alludes to the locomotive embryos described by Meyen, but cannot bring himself to admit the correctness of this observation.

In 1835, M. Dumortier published, in the 'Bulletin de l'Académie de Bruxelles,' a memoir on the "Polype à Panache" of Trembley.[‡] This Polyzoon, which had been previously confounded with *Alcyonella* and *Plumatella*, was believed by Dumortier to be sufficiently distinct to render it the type of a new genus, which he accordingly constituted, under the name of *Lophopus*. In consequence of using lenses of too low a power, Dumortier persuaded himself of the absence of cilia on the tentacula, and made this supposed fact the principal character in his new genus. Notwithstanding, however, the erroneous observation on which Dumortier thus relied, the separation of the "Polype à Panache" from the other fresh-water Polyzoa was an important step, and is fully borne out by its general structure.

The memoir of Dumortier is chiefly valuable as giving us the most complete account of the anatomy of the Polyzoa which had up to his time been published. To him is due the honour of having been the first to demonstrate a distinct nervous system in these animals; and he describes the cutaneous, circulatory, respiratory, manducatory, digestive, muscular, and reproductive systems, with much detail, and with a correctness which makes us the more surprised that he should have committed so grave an error respecting the tentacular cilia.

In the 'Bulletin Zoologique' of the same year, M. Gervais gives an analysis of the memoir of M. Dumortier, and contends against the right of the "Polype à Panache" to assume the position of a distinct genus, insisting on its being nothing more than a *Plumatella*.

In the year 1837, M. Turpin read before the Royal Academy of Sciences at Paris a memoir on *Cristatella*.[§] He had received, a short time previously, from M. Gervais, certain minute seed-like organic bodies, which this naturalist had discovered in the Canal d'Ourque, in the city of Paris. M. Turpin, suspecting them to be the ova of some aquatic animal, placed one of them in water, and, after some weeks, had the pleasure of seeing escape from it a minute polypoid animal, which he recognised as that figured and described by Rösel, and afterwards, under the name of *Cristatella*, assumed as the type of a new genus by Cuvier. Turpin describes the bodies from which these little animals proceeded with considerable detail, but his account is in many respects erroneous. He alludes to the annulus with which they are surrounded, but sets this appearance down as the result of an optical deception, and he incorrectly describes their curious hooked spines as, for the most part, growing from the extreme margin; while he tells us that the bodies in question open in a plain perpendicular to the two faces, to allow of the escape of the young one, instead of having the plane of dehiscence, as is really the case, parallel to the faces. He is at first at a loss to explain how such formidably armed "eggs" could be brought forth with impunity, and he asks "Quelle pouvait être la malheureuse mère condamnée à contenir et surtout à pondre des œufs aussi horriblement herissés de crochets?" He afterwards, however, finds an explanation of the difficulty, for seeing the fæces expelled in the form of oval masses, he mistakes these masses for eggs, and thence concludes that the eggs are at first free from spines, and acquire this armature only after being laid. M. Turpin gives a very beautiful figure of the young animal, which he describes with great care, though, not having the advantage of adult or of sufficiently numerous specimens, his account is in some respects erroneous.

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[*] De Blainville, 'Manuel d'Actinologie et de Zoophytologie.' Paris, 1834.

[†] Quoy et Gaimard, 'Zoologie du Voyage de l'Astrolabe.' Paris, 1830-33.

[‡] Dumortier, Recherches sur l'Anatomie et la Physiologie des Polypiers composés d'eau douce. 'Bull. Acad. Brux.,' ii, p. 422.

[§] Turpin, Etude microscopique de la *Cristatella mucedo*. 'Comptes rend. de l'Acad. Sci. Paris,' Jan., 1837; and 'Ann. Sci. Nat.,' 2e sér., vii, p. 65.

The same year, M. Gervais published another memoir on the fresh-water Polyzoa.[*] In this memoir he constitutes a distinct genus, under the name of *Paludicella*, for Ehrenberg's *Alcyonella articulata*; and he farther makes an important step in the classification of the Polyzoa, dividing them into two subordinate groups, *Polypiaria hippocrepia* and *Polypiaria infundibulata*, the former being constituted for those with the tentacula upon the margin of a horseshoe-shaped disc, and including all the fresh-water species except *Paludicella* and *Fredericella* (= *Tubularia sultana*, Blumenbach), which, in consequence of having the tentacula arranged on a circular disc, Gervais unites with the marine Polyzoa, to constitute the group *Polypiaria infundibulata*. We have already seen that De Blainville was impressed with the necessity of this division, and established his *Polypiaria dubia*, corresponding with Gervais's *P. hippocrepia*, to meet it; but De Blainville's group, including certain animals which are manifestly incorrectly placed there, required the revision introduced by Gervais. Gervais now corrects the erroneous description of the egg (statoblast) given by Turpin, but he tells us no new fact of importance concerning the animal, and he commits the serious error of uniting all the other species with crescentic discs under the single one of *Plumatella campanulata*.

About the same time, M. Turpin read to the Academy of Sciences a memoir on certain microscopic organized bodies which he found enveloped in some varieties of opal.[†] In these, he recognises so much similarity with the statoblasts of the *Cristatella*, with whose study he had just been engaged, that he does not hesitate to consider them as the eggs of some nearly allied animal. The fossils, however, thus attempted to be determined by Turpin, have nothing to do with the Polyzoa. There can be little doubt that they are the fossil sporangia of certain *Desmidieæ*.

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[*] GERVAIS, Recherches sur les Polypes d'eau douce des genres *Plumatella*, *Cristatella*, et *Paludicella*. 'Ann. Sc. Nat.,' 2^{e} sér., vii, 1837.

[†] TURPIN, Analyse ou Étude microscopique des différents corps organisés et autres corps de nature diverse qui peuvent accidentellement se trouver enveloppés dans la pâte translucide des Silex. 'Acad. Sc. Paris,' Mars, 1837.

In the 'Transactions of the Philosophical and Literary Society of Leeds,' 1837, we have a paper by Mr. Teale, on *Alcyonella stagnorum*.[*] The author gives a good account of the habits and external characters of the animal; but he informs us of no new fact concerning its anatomy.

In 1838, Johnston published the first edition of his excellent 'History of British Zoophytes;'[†] in the account, however, here given of the fresh-water Polyzoa, this author merely follows his predecessors. He distributes the species under the three genera of *Cristatella*, *Alcyonella*, and *Plumatella*; he makes the "Polype à Panache" merely one of the varieties of *Alcyonella stagnorum*, and, led astray by the erroneous synonymy of previous authors, he enumerates the *Plumatella gelatinosa* of Fleming's "British Animals" as a species with circular disc, distinct from Blumenbach's *Tubularia sultana*.

In the 'Bulletins de l'Académie Royale de Bruxelles' of the following year, M. Van Beneden published a note, containing observations on some of the fresh-water Polyzoa.[‡] Nordmann had just indicated the existence of male and female individuals existing separately in *Tendra zostericola*, a marine Polyzoon,[§] and M. Van Beneden now makes a similar statement with respect to *Alcyonella*.[||] He describes also a circulation of fluid in various parts of the body, and he supposes it due to the action of cilia, which he affirms to exist on the exterior of the alimentary canal as well as on the skin. This motion of the fluid in the interior had been, as we have seen, already noticed by Trembley; and M. Van Beneden now for the first time refers it to its true cause by showing its dependence on vibratile cilia, though he incorrectly describes the external surface of the alimentary canal as ciliated. He believes he has seen at the base of each tentacle an aperture, which he regards as an aquiferous mouth ("bouche aquifère"), destined to give admission to the external water; though in a subsequent memoir he admits that this appearance is deceptive. He describes the great supra-œsophageal ganglion, and mentions the existence of locomotive ciliated embryos in *Alcyonella*. He mentions having found, along with M. Gervais, the *Fredericella* and *Paludicella*; and in fine he shows how the form of *Alcyonella* is varied by accidental circumstances influencing its growth.

In the same year, M. Gervais published, in the 'Annales Françaises et Etrangères d'Anatomie,' a valuable paper on the fresh-water Polyzoa.[¶] This memoir, which is an extension of his previous one, is of more importance in a zoographical than in an anatomical point of view. For Blumenbach's *Tubularia sultana*, he institutes a new genus under the name of *Fredericella*, called in honour of Frederic Cuvier, and he gives a tolerably extensive synonymy of the species of fresh-water Polyzoa, which he distributes under the five genera, *Cristatella*, *Alcyonella*, *Plumatella*, *Paludicella*, and *Fredericella*; he, however, still maintains the generic identity of *Lophopus* and *Plumatella*. He divides the whole, as he had done in his previous paper, into two sub-classes, *Polypiaria hippocrepia* and *P. infundibulata*.

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[*] TEALE, On *Alcyonella stagnorum*. 'Trans. Phil. Soc. of Leeds,' i, p. 116.

[†] JOHNSTON, 'History of the British Zoophytes.' Edinburgh, 1838.

[‡] VAN BENEDEN, Quelques Observations sur les Polypes d'eau douce. 'Bull. Acad. Brux.,' 1839.

[§] NORDMANN, Recherches microscopiques sur l'anatomie et le développement du *Tendra zostericola*. 'Ann. Sci. Nat.,' 2e sér., xi.

[||] With Van Beneden's statement of the separation of the sexes in *Alcyonella*, my own observations do not agree. See above, p. 32.

[¶] GERVAIS, Observations sur les Polypes d'eau douce. 'Annales Françaises et Etrangères d'Anatomie,' 1839.

In the first volume of the Supplement to the 'Dictionnaire des Sciences Naturelles,' published in 1840, M. Gervais, in the article *Alcyonella*, again gives us the result of his researches into this subject; he still rejects the generic distinctness of *Lophopus*, and even views *Alcyonella* and *Plumatella* as mere species of the same generic form.

In 1841, M. Coste read to the Académie des Sciences a paper on the organization of the fresh-water Polyzoa;* though unaccompanied by figures, M. Coste's memoir gives a very good account of most of the important points in the anatomy of the hippocrepian Polyzoa; it describes the muscular, digestive, and nervous systems with much exactness and with considerable detail; and maintains the expediency of removing the Polyzoa out of the Radiata, and placing them among the Mollusca.

A few months later, M. Coste addressed to the Académie a short note on the "Tubulaire sultane" (*Fredericella sultana*),† in which he announces that the organisation of this Polyzoon is in general quite conformable to that of the hippocrepian species described in his former communication.

In the year 1842, MM. Dumortier and Van Beneden read, before the Royal Academy of Brussels, the first of a series of papers, which these naturalists proposed presenting conjointly, on 'the Compound Polypes of fresh water.'‡ This memoir consists entirely of a historical introduction to the subject; it is most elaborate and learned, and I have derived much assistance from it in drawing up the present historical outline.

In 1843, I read to the Royal Irish Academy a memoir 'On the Muscular System of *Paludicella* and other Ascidian Zoophytes of fresh water.'§ The paper is chiefly occupied with the description of the muscles of *Paludicella*. They are divided into three groups—one belonging to the alimentary canal, one to the tentacular sheath, and one to the walls of the cell. Being then an inexperienced observer, and possessing but an imperfect microscope, I was unable to pursue the anatomy of the animal as far as could be desired, and several interesting points of structure escaped me at the time. The retractor muscles of the alimentary canal in *Plumatella repens*, and the radiating muscles of its sheath, are also described in this memoir, though I then overlooked the fact that the latter are divisible into an anterior and a posterior set; while Dr. A. Farre's account of the action of certain muscles in the Polyzoa is examined, and an attempt made to explain such action in a manner somewhat different from the views entertained by this anatomist.

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* COSTE, Propositions sur l'organisation des polypes fluviatiles. 'Comptes Rendus,' 1841.

† COSTE, Observation relative à la Tubulaire sultane. 'Comptes Rendus,' 1841.

‡ DUMORTIER et VAN BENEDEN, Histoire Naturelle des Polypes composés d'eau douce. 'Nouveaux Mémoires de l'Acad. Roy. de Bruxelles,' t. xvi.

§ ALLMAN, On the Muscular System of *Paludicella* and other Ascidian Zoophytes of fresh water. 'Proc. Roy. Irish Acad.' 1843.

At the meeting of the British Association for the Advancement of Science, held at Cork, in the same year, I read a paper on *Plumatella repens.*[*] In this paper it was attempted to reduce to some sort of order the chaotic accumulation of synonyms by which the species is encumbered. This was facilitated by distinguishing two variations which *P. repens* is found to assume, according as it grows upon surfaces of small or large extent, and from not attending to which much confusion had arisen; one of these variations is presented in the "Federbusch-polyp" of Rösel, the other in the "Kammpolyp" of Schäffer, which Müller afterwards assumed as the form on which he founded his species *Tubularia repens.* The digestive apparatus was also described, as well as the muscles which act on the alimentary canal and invaginated tunic; it was shown that the latter muscles consisted of two distinct sets, an anterior and a posterior, whose peculiar arrangement was pointed out.

On the same occasion I presented to the meeting a short paper, containing a synopsis of the genera and species of fresh-water Polyzoa occurring in Ireland.[†] In this paper two new species of *Plumatella* and one of *Fredericella* are described, and the peculiarities of *Paludicella* were deemed of sufficient importance to raise this genus to the type of a distinct family among the fresh-water Polyzoa.

In 1846, I described, in a paper read before the Royal Irish Academy, the locomotive ciliated embryos of *Plumatella fruticosa*;[‡] and at the meeting of the British Association for the same year, presented to that body the result of some observations I had made on the structure of *Cristatella*.[§] The nervous ganglion of this Polyzoon was described, and the muscular fibre was shown to be striated, and to have a tendency to break into discs. The statoblasts (or the ova, as I then, in common with other observers, believed them to be), were described as enclosed, during their young state, in a ciliated membranous sac, within which the hooked spines, of which they are at first destitute, are afterwards developed.

In the second edition of the 'History of British Zoophytes,' published in 1847, Johnston subjects the portion of his work which treats of fresh-water Polyzoa to a complete revision, and now distributes the British species under the genera *Cristatella*, *Alcyonella*, *Plumatella*, *Fredericella*, and *Paludicella*; he, however, still maintains the specific identity of the "Polype à Panache" with the *Alcyonella stagnarum*.

In 1848, we obtain from M. Van Beneden a very valuable memoir on the fresh-water Polyzoa of Belgium.[‖] The author here enters into important details of the anatomy and classification of the fresh-water Polyzoa, and gives excellent descriptions and copious synonyms of the several species. After the lapse of nearly a century, he restores to the *Alcyonella stagnarum* of Lamarck the specific name *fungosa* originally bestowed on it by Pallas. This is but an act of justice to its discoverer, and ought to be followed by subsequent systematists. Van Beneden also makes the addition of a second species of *Alcyonella*, which he describes under the name of *A. flabellum*.

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[*] Allman, On *Plumatella repens*. 'Reports of British Association,' 1843.

[†] Allman, Synopsis of the genera and species of Zoophytes inhabiting the fresh waters of Ireland. 'Reports of British Association,' 1843; and 'Ann. and Mag. of Nat. Hist.,' May, 1844.

[‡] Allman, On the Larva state of *Plumatella*. 'Proc. R. I. Ac.,' 1846.

[§] Allman, On the Structure of *Cristatella mucedo*. 'Reports of British Association,' 1846.

[‖] Van Beneden, Recherches sur les Bryozoaires Fluviatiles de Belgique. 'Mém. de l'Acad. Roy. de Belgique,' tome xxi, 1848.

In the same year, MM. Dumortier and Van Beneden presented, conjointly, to the Royal Academy of Sciences at Brussels, a second and very important memoir on the 'Natural History of the fresh-water Polyzoa.'* This memoir is occupied with the anatomy of the genera *Paludicella*, *Fredericella*, *Alcyonella*, and *Lophopus*, and accompanied by numerous well-executed figures. It contains extensive and careful anatomical details of all the genera treated of in the memoir. It describes and figures with much minuteness the development of the bud in *Paludicella*, and mentions the occurrence of a peculiar winter bud in this Polyzoon, occupying the position of the ordinary buds, but destined to remain during the winter months in an undeveloped state. The structure of the testicle in *Alcyonella* is examined, and the spermatozoa, with their vesicles of evolution, demonstrated; but these cells are not sufficiently distinguished from the contained spermatozoon. The ciliated embryos of *Alcyonella* are also described and figured, but the authors do not pursue their development into much detail, while they consider them as identical with statoblasts in a particular stage of evolution, and deprived of their external shell. The statoblasts themselves in *Alcyonella* and *Fredericella* are described, but the essential structure of an ovum is attributed to them, while some confusion has arisen with regard to the statoblast of *Lophopus crystallinus*, the body described as such being manifestly the statoblast of *Cristatella*. A statement formerly made by M. Dumortier, that the tentacula of *Lophopus crystallinus* are deprived of cilia, is repeated here: it is asserted that, instead of ciliary vibrations, the tentacula of this Polyzoon present a moniliform current, which ascends one side and descends the other of each tentacle; the appearance of these currents is compared to that of an endless chain in uninterrupted motion, and attention is drawn to the analogy of this phenomenon with that of the decomposition of water by the galvanic battery. I have no doubt, however, that the phenomenon thus described is truly a case of ciliary vibration, and that the cilia have merely escaped the observer in consequence of some defect in the microscope employed in their investigation. I have repeatedly had under my own observation a species of *Lophopus*, which I do not hesitate to refer to M. Dumortier's species, and yet I found the cilia in all cases perfectly distinct. An opinion previously expressed by M. Van Beneden, when he thought he had seen apertures ("bouches aquifères") for the admission of water into the perigastric space, is here given up, and the source of the error pointed out. Further, M. Van Beneden, now finding a testicle in the same cell with the statoblasts, modifies his previous views as to the unisexualism of *Alcyonella*, and, comparing this Polyzoon to the plants belonging to the twenty-third class of Linnæus, he suggests that male, female, and hermaphrodite individuals may all coexist in the same cœnœcium. On the whole, this memoir of the learned Belgian naturalists, though in some respects incorrect, must be regarded as the most important, in an anatomical point of view, of any which had as yet appeared.

In the same year (1848), Sir J. G. Dalyell published the second volume of his 'Rare and Remarkable Animals of Scotland,'† and described in this work several species of fresh-water Polyzoa, as inhabitants of that part of the British Islands. Dalyell is a truthful observer and a graphical describer of the habits of the lower invertebrate animals, but he is not always acquainted with the labours of others in the same field; and in the case of the fresh-water Polyzoa, it is often extremely difficult to identify his species—a difficulty much enhanced by the want of exactness in his numerous figures. Under Lamarck's name of *Cristatella vagans*, he describes the *C. mucedo* (Cuvier), and is the first after Gervais to figure fully-developed specimens of this beautiful Polyzoon. Under the name of *Alcyonella gelatinosa* he describes the true *Alcyonella fungosa*, while his *Alcyonella stagnarum* appears to be the young condition of a *Plumatella*. His *Plumatella repens* would seem to include more than one species, but neither from his descriptions nor figures is it possible to determine the exact animal intended.

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* Dumortier et Van Beneden, Hist. Nat. des Polypes composés d'eau douce, 2e partie. Complément au tome xvi des 'Mém. de l'Acad. Roy. des Sciences et Belles-lettres de Bruxelles,' 1848.

† Dalyell, 'Rare and Remarkable Animals of Scotland, represented from living subjects.' London, 1847-8.

At the meeting of the British Association for 1849, I noticed the addition to the Irish Fauna, of *Lophopus crystallinus*, which I had found abundantly in the pond of the Zoological Gardens near Dublin,* and described a new species of *Plumatella* (*P. coralloides* of the present monograph); and on the same occasion I described the distribution of the nerves in *Plumatella repens*.†

In January, 1850, I presented to the Royal Irish Academy, a memoir on the 'Natural History of the genus *Alcyonella*.'‡ This memoir contained a historical introduction to the subject, recorded the addition to the British Fauna of the *A. flabellum* of Van Beneden, and gave a detailed account of the anatomy of *A. fungosa*. The muscles of this Polyzoon were divided into eight distinct sets, the distribution of the nervous system was demonstrated, and the structure of the locomotive embryos was described, and certain errors in the description given by Meyen of these bodies were pointed out.

In the same year, Mr. Albany Hancock, already well known by numerous important papers on the anatomy of the Mollusca, but especially by his association with Mr. Alder in their beautiful 'Monograph on the *Nudibranchiata*,' published an admirable paper on certain species of fresh-water Polyzoa obtained in a small lake in Northumberland.§ In this paper the author gives a very full account of the anatomy of *Plumatella*, *Fredericella*, and *Paludicella*, characterised by great accuracy, and illustrated by excellent figures, though in some points, as already noted in the anatomical portion of the present work, I have found reason to differ from his conclusions. He also draws attention to the resemblance between the arms of the lophophore in the hippocrepian Polyzoa and the oral arms of the Brachiopoda, and compares the arrangement and action of certain muscles in the two groups—important points tending to throw light on the affinities of the Polyzoa. The same paper contains descriptions of new species, which the author records under the names of *Plumatella punctata*, *P. Allmani*, and *Paludicella procumbens*. After carefully considering Mr. Hancock's description of his *Paludicella procumbens*, I cannot satisfy myself that the characters on which the species is founded are sufficient to entitle it to be considered distinct from *P. Ehrenbergi*;

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* Allman, On *Lophopus crystallinus*. 'Reports of British Association,' 1849.

† Allman, On the Nervous System and certain other points in the Anatomy of the *Bryozoa*. 'Reports of British Association,' 1849.

‡ Allman, The Natural History of the genus *Alcyonella*. 'Proceedings of Royal Irish Academy,' 1850.

§ Hancock, On the Anatomy of the fresh-water Bryozoa, with descriptions of three new species. 'Ann. and Mag. Nat. Hist.,' March, 1850.

the most important difference, consisting in the greater number of tentacula, is founded on a figure of *Paludicella Ehrenbergi*, given by myself some years before, and which having been incorrectly engraved with too many tentacles, has thus unfortunately become a source of error in Mr. Hancock's determination of the Northumberland species.

In the same year, I presented to the British Association a report on the state of our knowledge of the fresh-water Polyzoa,* in which it was my object to give a detailed account of the anatomy of these animals, and a synopsis, with diagnoses, of all the known species; and in the year 1852, I read, before the Royal Irish Academy, a memoir on the homologies of the organs in the Tunicata and Polyzoa,† in which the fresh-water hippocrepian forms were adduced as affording a means of clearing up some difficult points in the homological relations of the two groups.

In 1851, we find several communications on the subject of the fresh-water Polyzoa of Pennsylvania, presented by Dr. Joseph Leidy to the Academy of Natural Sciences of Philadelphia.‡ In these the author describes some new species of *Plumatella*, and two new genera (*Pectinatella*, Leidy, and *Urnatella*, Leidy) of fresh-water Polyzoa.

In 1854, Leidy presented to the Academy an additional notice,§ in which, with an amended diagnosis of *Urnatella*, he confirms the claim of this animal to rank as a distinct genus of fresh-water Polyzoa; while, at the same time, he describes another new species of *Plumatella*. Leidy's account of *Urnatella* is confined to a simple diagnosis, but the author proposes to give, hereafter, a full description of the genus. Leidy's communications on the subject of the fresh-water Polyzoa must be regarded as among the most important contributions in a zoographical point of view which have of late years been made to this department of natural history.

For some years past, I have continued to make the fresh-water Polyzoa the subject of careful study, and the result has been the acquisition of many new facts, and the correction of some errors into which I had previously fallen. The later additions which I have thus succeeded in making to our knowledge of these animals have been hitherto unpublished, and are now, in the present monograph, for the first time made known.

2.

HABITS OF THE FRESH-WATER POLYZOA.

Besides presenting well-marked differences in form, the fresh-water Polyzoa differ also considerably from one another in their habits. Some delight in the pure clear water of subalpine lakes or of rapid rivulets, where, by close adhesion to the under surface of stones, they avoid the danger of being carried away by the current of the stream; while others prefer slowly running rivers or the sluggish waters of canals and ponds.

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* ALLMAN, Report on the present state of our knowledge of the fresh-water Polyzoa. 'Report of British Association,' 1850.

† ALLMAN, On the Homology of the Organs of the Tunicata and the Polyzoa. 'Transactions of the Royal Irish Academy,' vol. xxii, 1852.

‡ LEIDY, in 'Proceedings of the Academy of Natural Sciences of Philadelphia,' vol. v, pp. 261, 265, 321.

§ *Id.*, vol vii, p. 191.

They are almost all light-shunning animals, loving the dark and gloomy recesses of the lakes and rivers they frequent, where they may be found beneath the shade of aquatic plants, or attached to the inferior surface of stones, or lurking under the arches of bridges where a ray of direct sunlight never enters; *Cristatella* alone delights in exposure to the full influence of the solar beams, and may be seen basking upon the upper side of submerged stones, or creeping over the stems of aquatic plants in the clear waters of lakes and ponds.

With the solitary exception of *Cristatella*, they are all, in their adult condition, utterly incapable of locomotion, being then permanently attached to some fixed object; *Cristatella*, however, creeps about on the stones and plants of its native lake, and thus affords the only instance as yet known of a truly locomotive Polyzoon.

Lastly, some are timid creatures, withdrawing into the recesses of their cells on the slightest disturbance, and not again daring to venture forth until a long lapse of time has convinced them that all is once more quiet without; while others must be roughly handled before they will think of retreating; and the light-loving *Cristatella* rejoices in the constant exposure of its plumy crown, no ordinary disturbance will force it to retire, it seems altogether incapable of existing, except in the midst of the countless vortices which its ciliated tentacula are for ever whirling around it.

3.

General Geographical range of the Fresh-water Polyzoa.

The number of forms of fresh-water Polyzoa which, after careful comparison, I have deemed it right to retain as distinct species, amount to twenty-one in all. Of these, sixteen are British; and of the remaining five, one has only been described as occurring in the fresh waters of Belgium, while four are confined to the United States of America Of these four American species, two constitute respectively the types of two distinct genera.

We do not, however, as yet possess a sufficient number of observations to entitle us to advance any generalisation of much value as to the geographical distribution of the fresh-water Polyzoa. The most northern point at which we have any positive information of the discovery of a species is probably the neighbourhood of Stockholm (Bæck, in 'Acta Holm., vii, 1745), while the neighbourhood of Nice (Risso, 'Hist. Nat. de l'Europe Mérid.') would seem as far as is yet known to be the most southern limit of the group in the Eastern Hemisphere, and Philadelphia (Leidy, 'Proceed. Acad. Nat. Sci. of Philadelphia,' vols. v and vii) to be the most southern limit at which we have any record of a fresh-water Polyzoon having been discovered in the Western Hemisphere. Vlademir, in Central Russia, where *Alcyonella fungosa* was originally found by Pallas (Pallas, in 'Nov. Comm. Petr.,' 1768), is the most eastern point, while Philadelphia (Leidy, l. c.) must for the present be viewed as the extreme limit towards the west.

The species, so far as we are as yet acquainted with their distribution, are thus confined to the North Temperate Zone, not one having been recorded as occurring south of the Mediterranean in the Old World, or of Philadelphia in the New. It is by no means improbable that they also exist in warmer latitudes, and we cannot but be surprised that they should have escaped the explorations of the numerous naturalists who have examined the regions lying further towards the tropics. We know that the fresh-water tanks in India have been subjected to examination, both botanically and zoologically; and though we should naturally expect to find the fresh-water Polyzoa luxuriating in such a habitat, none of the naturalists who have described the productions of these reservoirs make any mention of them; and yet the species of *Spongilla* which abound there, and whose European representatives are so frequently found associated with Polyzoa, have been made the subject of interesting and elaborate investigations.

The United States of America appear to be especially rich in the fresh-water Polyzoa; and when we bear in mind, that it is but lately that these animals have received the attention of American naturalists, while but a small portion of that part of the world has hitherto been examined with special reference to them, and that nevertheless—though all the European species have not yet been recorded as living there—two entirely new generic types have been brought to light, while many of the species found present a state of luxuriant development of which we know nothing in the Old World,—when we bear in mind all these facts, we can scarcely avoid the belief that North America will yet prove the grand metropolis of the tribe.

Further facts must be obtained, before we can arrive at any generalisations of much importance regarding the altitudinal distribution of the Polyzoa. All the British fresh-water species occur in these islands at the level of the sea, and most of them have also been met with in our alpine and subalpine lakes. I have found *Plumatella repens* and *P. fruticosa* in Lac Leculejo in the Pyrenees, at an altitude of 4590 feet; and *P. repens* in Lac d'Aul, another Pyrenean lake, at an altitude of about 6500 feet, which is the greatest elevation at which any Polyzoon has as yet been recorded.

The depth at which the fresh-water Polyzoa occur in the waters frequented by them is never considerable. I have met with *Plumatella jugalis* attached to the long petioles of *Nymphæa alba*, in the waters of a sluggish canal, at about four feet below the surface; but in most instances, the fresh-water Polyzoa will be found at much less depths, and frequently at the very surface, attached to the under side of floating leaves, or upon the stones at the margin of lakes, where they are exposed to the ripple as it breaks upon the shore.

4.

Condensed Synopsis of the Orders, Sub-orders, Families, and Genera.

The fresh-water Polyzoa admit of being divided into eight generic groups. The discrimination of these is very easy in the living animal; but as some of the genera are founded on the form of the *polypide* alone, the *cœnœcium* not presenting one character which can be employed for the purposes of distinction; while in others the form of the entire animal is so changed by death, as to render it almost utterly incapable of conveying any idea of what it had been, we are in most instances obliged to examine the animal in a living state before we can form any safe opinion as to even the genus to which it belongs.

The following is a condensed synopsis of the orders, sub-orders, families, and genera of fresh-water Polyzoa:

Orders.*	Sub-Orders.	Families.				Genera.
PHYLACTOLÆMATA.	LOPHOPEA.	Cœnœcium free, locomotive.	Cristatellidæ.			Cristatella.
		Cœnœcium rooted.	Plumatellidæ.	Lophophore with two long arms.	Cœnœcium massive; ectocyst gelatinoid; statoblasts orbicular, with marginal spines.	Pectinatella.
					Cœnœcium sacciform; ectocyst gelatinoid; statoblasts oval, destitute of spines.	Lophopus.
					Cœnœcium tubular, tubes united; ectocyst pergamentaceous.	Alcyonella.
					Cœnœcium tubular, tubes distinct; ectocyst pergamentaceous.	Plumatella.
				Arms of lophophore obsolete.		Fredericella.
GYMNOLÆMATA.	URNATELLEA.		Urnatellidæ.			Urnatella.
	PALUDICELLEA.		Paludicellidæ.			Paludicella.

* For the characters of the Orders and Sub-Orders see Table, p. 10.

5.

DIAGNOSIS, SYNONYMY, AND NATURAL HISTORY OF THE GENERA AND SPECIES.

CRISTATELLIDÆ.

Genus I. CRISTATELLA, *Cuvier*, 1798.

Name.—A diminutive noun formed from *crista*, a crest, in allusion to its tentacular plume.

The genus *Cristatella* was established by Cuvier, for the little animal originally described by Rösel under the title of "Der Kleinere Federbusch Polyp mit dem ballenförmigen Körper." Its characters were given in the 'Tableau Elémentaire des Animaux,' published in 1798, and it is the first generic group constituted for any of the fresh-water Polyzoa, hitherto all confounded together in discordant and unzoological associations. Rösel's animal. however, was unknown to Cuvier, except from the figures and descriptions left us by its discoverer; and it was not until Turpin and Gervais many years afterwards rediscovered it, having hatched it from statoblasts found in the Canal d'Ourcq, in the city of Paris, that any additions were made to the original account left us by Rösel. Still, however, nothing was known of the animal but in its young and partially developed state, and it was only afterwards, when adult and fully formed specimens were met with, that the real nature of this beautiful Polyzoon was properly understood.

The genus, which includes as yet but a single species, may be thus characterised:

Generic character.—Cœnœcium sacciform, hyaline, with a common flattened disc adapted for locomotion; orifices placed on the surface opposite to the disc, and arranged in several concentric marginal series. Statoblasts orbicular, with an annulus and marginal spines.

Species unica. *Cristatella mucedo*, Cuvier. Pl. I.

Specific character.—Same as that of the genus.

SYNONYMS.—1755. *Der Kleinere Federbusch-Polyp.* Rösel, Insect. Belustig. Supp., p. 559, tab. 91. (Original figure.)

1766. *La seconde sorte de Polypes à Bouquets.* Ledermuller, Amusm. Mic. 2de cinq., p. 94, pl. 87. (The figures are imperfect copies from Rösel.)

1798. *Cristatella mucedo.* Cuvier, Tab. Elém., p. 656.

1816. *Cristatella vagans.* Lamk., An. sans Vert., 1st edit., vol. ii, p. 97.

1817. *Cristatella mucedo.* Cuv., Règne A., 1st edit., vol. iv, p. 68.

1820. *Cristatella vagans.* Schweigger, Handbuch der Naturg. p. 423.

1824. *Cristatella vagans.* Lamouroux, Enc. Méth. Zooph., p. 226, pl. 472. (Figures copied from Rösel.)

1824. *Cristatella vagans.* Goldfuss, Naturhistorisch Atlas. (Figures copied from Rösel.)

1828. *Alcyonella, secundus evolutionis gradus.* Raspail, Hist. Nat. de l'Alcyon. fluv., Mém. de la Soc. d'Hist. Nat. de Paris, vol. iv, p. 129.

1830. *Cristatella mucedo.* Cuvier, Règ. An., 2d edit., vol. iii, p. 296.

1834. *Cristatella mirabilis.* Dalyell, Rep. Brit. Assoc., p. 604; and Edinb. New Phil. Journ., vol. xviii, p. 414.

1834. *Cristatella vagans.* De Blainville, Man. d'Act., p. 489, pl. 85, fig. 7. (Figure copied from Rösel.)

1834. *Cristatella vagans.* De Blainville, Dict. Sc. Nat., art. *Cristatelle,* fig. 7. (Figure copied from Rösel.)

1836. *Cristatella vagans.* Lamarck, An. sans Vert., 2d edit., vol. ii, p. 110.

1837. *Cristatella mucedo.* Turpin, Ann. Sc. Nat., 2d series, tom. vii, p. 65, pl. 2, 3 (Original figures.)

1837. *Cristatella mucedo.* Gervais, Ann. Sc. Nat., 2d series, tom. vii, p. 77, pl. 4. (Original figures.)

1838. *Cristatella mucedo.* Johnston, Brit. Zooph., 1st edit., p. 308, pl. 43. (Figures copied from Turpin.)

1839. *Cristatella mucedo.* Gervais, Ann. Franç. et Etrang. d'Anat., tom. iii, p. 133.

1840. *Cristatella moisissure.* Gervais, Dict. Sc. Nat. Suppl., art. *Alcyonelle,* Planches Supplémentaires, Pol. fluviatiles. (Original figures.)

1843. *Cristatella mucedo.* Thompson, Rep. Brit. Assoc., p. 285.

1844. *Cristatella mucedo.* Allman, Ann. of Nat. Hist., vol. xiii, p. 330.

1846. *Cristatella mucedo.* Allman, Rep. Brit. Assoc., Trans. of Sect., p. 88.

1847. *Cristatella mucedo.* Johnston, Brit. Zooph., 2d edit., p. 387, pl. 73. (Figures copied from Turpin.)

1848. *Cristatella mucedo.* Van Beneden, Bryoz. Fluv. de Belg., p. 16; Mém. de l'Acad. Roy. de Belgique.

1848. *Cristatella mirabilis.* Dalyell, Rare and Remarkable Animals of Scotland, vol. ii. (Original figures.)

Iconography.—The original figures are those of Rösel, Turpin, Gervais in 'Ann. Sc. Nat.,' Gervais in 'Dict. Sc. Nat.' Suppl., and Dalyell.

HABITAT.—In clear lakes and ponds, where it creeps slowly over the upper side of submerged stones and the stems of aquatic plants, delighting in sunlight.

LOCALITIES.—*British:* A millpond near Little Baddow, Essex; Union Canal, Edinburgh; a beautiful little subalpine lake near Glandore, County Cork; Lakes of Killarney, Grand Canal, Dublin; a lake near Armagh, and several other Irish localities. *G. J. A.*—Duddingston Loch, near Edinburgh; Coldingham Loch, Berwick; a garden pond at Binns House, Linlithgowshire. *Sir J. G. Dalyell.*

Foreign: Lake of Lucerne; "Grand Etang," Fontainbleau. *G. J. A.*—Near Paris. *Gervais and Turpin.*—Belgium. *Van Beneden.*—Germany. *Rösel.*

The first perfectly developed specimen of *Cristatella mucedo* was described in 1834, by Sir John Graham Dalyell, who discovered it near Edinburgh, and perceiving it to be so very different from previous descriptions and figures, looked upon it as a new species, and named it *C. mirabilis.** Adult specimens have since been found by M. Gervais, and I have met with them in abundance in Ireland, and in other parts of the British Isles.

A more interesting and beautiful animal than a fully developed specimen of *Cristatella mucedo* can scarcely be imagined. The entire colony is of an oval shape, convex above and flat below, where it attaches itself to neighbouring objects. Upon the convex surface are arranged the orifices through which the polypides emerge, they are placed near the margin, and run round the entire cœnœcium in three regular concentric series, which alternate with one another, and leave an oval space in the centre where no orifices exist.

In the middle of the flattened under surface is an oval disc, resembling the foot of a gasteropodous mollusc; on this disc, which is contractile, and admits of frequent change of shape, the colony adheres to neighbouring objects, or creeps about on the submerged leaves and stems of aquatic plants. From the edges of the disc a flat space extends outwards, passing beyond the external series of orifices in the form of a projecting margin, whose interior is occupied by a series of tubular cells or chambers, visible through the translucent skin, and extending in a radiating direction from the disc outwards, but possessing no external opening.

The tentacula are about eighty in number, being more numerous than in any other known Polyzoon, except, perhaps, *Pectinatella*, Leidy. The cœnœcium is of a dull yellow, or sienna colour. The polypide is nearly of the same colour, with the exception of the intestine, which, in well-fed, healthy specimens, is light bluish-green.

The largest specimens measure about two inches in length and a quarter of an inch in breadth, and, with the polypides extended, are, at the first glance, not unlike certain hairy caterpillars, or, as M. Gervais has aptly enough suggested, the silk fabric known by the name of *Chenille*. Such large specimens are very sluggish, and change their place with reluctance, at least when kept in confinement; but specimens of about half an inch in length creep about on the sides of the jar in which they are preserved at the rate of several inches in the day; they generally prefer keeping near the surface of the water, and seem to be much under the influence of light; indeed, while the greater number of the fresh-water Polyzoa lurk on the under surface of stones and in dark recesses, *Cristatella* loves to expose itself to the full light and warmth of the sun. It differs, moreover, from all the Polyzoa with whose habits I am acquainted, in the constant pleasure it takes in maintaining its polypides in the exserted state; these, indeed, must be very roughly handled to cause them to withdraw into their cells; and the annoyance is no sooner removed than they again emerge. This exquisite little Polyzoon seems, in fact, capable of existing only under the full influence of light, and in the midst of the innumerable vortices excited in the surrounding water by the vibratile cilia of its tentacles.

The statoblasts are very characteristic. They are about $\frac{1}{25}$ of an inch in diameter, exclusive of the marginal spines, and, with the exception of the statoblasts of *Pectinatella*, which they closely resemble, are larger than those of any other fresh-water Polyzoon. They are also, with the same exception, the only ones having an orbicular shape. One face is a little more convex than the other. The annulus is wide, very distinctly cellular, and of a light yellow colour. The disc is deep reddish-brown, and elegantly mamillated. The spines spring from both faces of the disc, just within the annulus, and thence radiate outwards, extending for some distance beyond the margin. The spines springing from the more convex face are somewhat longer and more numerous than the others, and alternate with them. All the spines are terminated by two, three, or four curved hooks resembling grappling-irons. Towards the end of summer, the statoblasts occur in considerable numbers in the interior of full-grown specimens, and are visible through the transparent tissues of the animal. On the death and decay of the cœnœcium they are liberated, when they become attached, by means of their hooked spines, to various aquatic plants, and ultimately open for the escape of the young, by the separation of the two faces, at the commencement of the following summer. The young, on its escape from the statoblast, is at first solitary, but is rapidly multiplied by the production of gemmæ.

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* 'Report of Meeting of British Association, held at Edinburgh, 1834.'

I have never met with *Cristatella* later than the autumn; it seems to be strictly annual in its duration.

PLUMATELLIDÆ.

Genus II. PECTINATELLA, *Leidy*, 1851.

Name.—A diminutive noun, formed from *pecten*, a comb, in allusion to the form of its tentacular crown.

In the 'Proceedings of the Academy of Natural Sciences of Philadelphia' for September, 1851, a new fresh-water Polyzoon is described by Dr. Joseph Leidy, under the name of *Cristatella magnifica*. The statoblasts of this animal resemble those of *Cristatella mucedo*, and it was this character which induced Leidy to refer his new Polyzoon to the genus *Cristatella*. It is not, however, furnished with a disc fitted for locomotion, and it has the orifices scattered irregularly over the surface, characters which bring it very near to *Lophopus*, but which at once exclude it from the genus to which Leidy had referred it. Of the untenableness of this association the author became almost immediately aware, and, in the next number of the 'Proceedings,' he instituted for it a new genus, with the following diagnosis:

Generic character.—"Cœnœcium massive, gelatinoid, hyaline, fixed, investing bodies; orifices arranged in irregular lobate areolæ upon the free surface. Lophophore crescentic. Ova (statoblasts) lenticular, with an annulus and marginal spines." *Leidy*.

Species unica. *Pectinatella magnifica*, Leidy.

Specific character.—Same as that of the genus.

SYNONYMS.—1851. *Cristatella magnifica*. Leidy, Proc. Acad. Nat. Sci. of Philadelphia, Sept., 1851.
1851. *Pectinatella magnifica*. Leidy, Proc. Acad. Nat. Sci. of Philadelphia, Nov., 1851.

Iconography.—No published figure.

HABITAT.—"Ditches and sluggish streams; found only in shady situations; always incrusting dead branches of trees." *Leidy*.

LOCALITIES.—"About Philadelphia." *Leidy*.

It is greatly to be regretted that we have no published figure of this beautiful Polyzoon, which must well deserve the name by which the species is designated. Dr. Leidy gives us the following more detailed description of it:

"Polypidom massive, incrusting bodies, from a few inches to several feet in length, by a few lines to two inches in diameter; gelatinoid, consistent, hyaline, with numerous polypi upon the free surface arranged in close irregular areolæ. Polypi furnished with two lobes, conjoined together in the form of U, enclosing the mouth at the base, and having, diverging from the margin, from 50 to 80 sigmoid tentacula arranged at the summit in the double outline of U, with the extremities of the arms of the latter inclining towards each other; lip elevated, with the base of the tentacular lobes and the lower-fourth of the inner margin of the tentacula in the vicinity of the mouth, lake or dark rose-red colour; œsophagus colourless; stomach longitudinally folded, yellowish-brown; rectum dilatable, hyaline, its extremity slightly projecting, but retractile; length from the bottom of the stomach to the top of the extended tentacula, 1¼ line; long diameter of tentacular expanse, ½ to ⅔ of a line; length of tentacula, 1/40 of an inch; breadth, 1/1000 of an inch.

"Ovum (statoblast) lenticular, brown, enclosed at the margin by a brownish-white annular cellular sheath, 1/75 of an inch deep upon one side, 1/100 of an inch on the other, furnished at its outer edge with 14 to 16 appendages, 1/150 inch long, terminating in a double, rarely a triple, hooklet. Ovum (statoblast), with its sheath, thin, discoidal, bent, 1/25 inch broad, with its appendages enveloped in a hyaline, albuminoid mass; when ripe, floating.

"The surface of the polype mass has the appearance of being covered with a dense mucor from the numerous tentacula projecting from it. Immediately beneath this, is a layer having a faint roseate hue, from the red colouring in the vicinity of the mouth of the polypi; then succeeds a layer of a dirty-yellowish colour, arising from the stomachs of the animals; beneath which are numerous opaque, white, yellowish, and brown spots, which are ova in various stages of development; and, finally, the greater depth of the mass consists of a perfectly hyaline, consistent, gelatinoid substance.

"The animal is not so irritable as *Plumatella*, but is, like it, capable of entirely retracting within its tube, in which state the stomach appears transversely wrinkled.

"The ova, as they are detached from the mass, rise nearer to the surface of the water, and float."

The luxuriance of growth of *Pectinatella magnifica* in the only locality which has as yet been recorded for it, is especially worthy of attention. It would seem, indeed, that the masses formed by it attain to a size which surpasses that of any other species. It is certainly one of the noblest of the fresh-water Polyzoa; and it is much to be hoped that its discoverer will not long delay in giving us a figure, with anatomical details, of so beautiful and interesting an animal.

Genus III. LOPHOPUS, *Dumortier*, 1835.

Name.—From λόφος, a crest, and πούς, a foot.

In a historical point of view, *Lophopus* is the most interesting genus of the entire class. The "Polype à Panache," discovered by Trembley, in 1741, was the first Polyzoon of which we have any record. It long continued to be confounded with species of *Plumatella* and *Alcyonella*, until Dumortier, rediscovering it in 1834, and perceiving its distinctness, assumed it as the type of a new genus, and described it under the name of *Lophopus crystallinus.* Though the characters given by Dumortier to his new genus are not entirely correct, yet with some alterations in his diagnosis, *Lophopus* must be preserved as a well-marked and easily characterised generic form.

Shortly after the original discovery of the "Polype à Panache," the same animal was met with in England by Baker, who described it under the appellation of the "Bellflower animal." M. Van Beneden believes Baker's animal to be distinct from that of Trembley, and describes it by the name of *Lophopus Bakeri;* but there are certainly no grounds for this distinction. Indeed, I am convinced that the animal called *L. Bakeri* by Van Beneden, and which has been so beautifully figured by this naturalist, is entirely identical with *L. crystallinus;* I must therefore still consider the genus as consisting of but a single species, the original "Polype à Panache" of Trembley.

Generic character.—Cœnœcium sacciform, hyaline, with a disc which serves for attachment but not for locomotion; ectocyst gelatinoid; orifices scattered. Statoblasts elliptical, with an annulus, but without marginal spines.

Species unica. *Lophopus crystallinus*, Pallas. Pl. II.

Specific character.—Same as that of the genus.

SYNONYMS.—1744. *Polype à Panache.* Trembley, Mém. sur les Pol. d'eau douce, p. 210, tab. 10, figs. 8, 9. (Original figures.)
1746. *Polype à Panache.* Bæck, Acta Suecica, p. 198, tab. 6, figs. 3, 4. (Figures copied from Trembley.)
1753. *Bell-flower Animal.* Baker, Employment for the Microscope, p. 306, pl. 12, figs. 15-22. (Original figures.)
1766. *Tubularia crystallina.* Pallas, Elenchus Zooph., p. 88.
1767. *Tubularia campanulata.* Linnæus, Syst. Nat., edit. xii.
1789. *Tubularia reptans.* Linn., Syst. Nat. cura Gmelin, p. 3835.
1789. *Campanulated Tubularia.* Shaw, Nat. Miscel., tab. 354. (Original figure.)
1806. *Tubularia campanulata.* Turton, Linn., Syst. Nat., vol. iv, p. 668.
1816. *Plumatella cristata.* Lamarck, Hist. des An. sans Vert., 1st edit., vol. ii, p. 107.

1820. *Plumatella cristata.* Schweigger, Handbuch der Naturg., p. 424.
1821. *Naisa reptans.* Lamouroux, Exp. Méth., p. 16, tab. 68, figs. 3, 4. (Figures copied from Trembley.)
1824. *Naisa reptans.* Deslongchamps, Encyc. Méth. Zooph., 1824, p. 561.
1826. *Plumatella cristata.* Blainville, Dict. Sci. Nat., tom. xlii, art. *Plumatella.*
1828. *Alcyonella, tertius evolutionis gradus.* Raspail, Hist. Nat. de l'Alc. Fluv., Mém. de la Soc. d'Hist. Nat. de Paris, vol. iv, p. 129.
1834. *Plumatella cristata.* Blainville, Man. d'Actin., p. 490.
1835. *Lophopus crystallinus.* Dumortier, Bull. de l'Acad. de Brux., 1835, p. 424, pl. 5, 6. (Original figures.)
1836. *Plumatella cristata.* Lamarck, An. sans Vert., 2d edit., vol. ii, p. 122.
1837. *Plumatella campanulata.* Gervais, Ann. Sc. Nat., 2d ser., tom. vii, p. 78.
1838. *Alcyonella stagnorum.* Johnston, Brit. Zooph., 1st edit., p. 311, fig. 48, p. 314. (Figure copied from Trembley.)
1839. *Plumatella crystallina.* Gervais, Ann. Franç. et Etrang. d'Anat., tom. iii, p. 134.
1844. *Alcyonella stagnorum.* Allman, Ann. Nat. Hist., vol. xii, p. 330.
1847. *Alcyonella stagnorum.* Johnston, Brit. Zooph., 2d edit., p. 391, fig. 73, p. 395. (Figure copied from Trembley.)
1848. *Lophopus crystallinus.* Van Beneden, Sur les Bryoz. fluv. de Belg., p. 23, Mém. de l'Acad. Roy. de Belg.
1848. *Lophopus Bakeri.* Van Beneden, Sur les Bryoz. fluv. de Belg., p. 24, pl. 2, Mém. de l'Acad. Roy. de Belg. (Original figure.)
1849. *Lophopus crystallinus.* Allman, Rep. Brit. Assoc., Trans. of Sect., p. 72.

Iconography.—The original figures are those of Trembley, Baker, Shaw, Dumortier, and Van Beneden.

HABITAT.—In ponds and ditches, where it attaches itself to the submerged parts of Lemna, Sparganium, and various other aquatic plants, avoiding exposure to bright sunlight.

LOCALITIES.—*British:* Abundant in a millpond near Little Baddow, Essex; a pond in the Zoological Gardens, Dublin; abundant. *G. J. A.*—In the water by the side of the Willow-walk, Chelsea, and in various waters in the neighbourhood of London. *Shaw.*
Foreign: Holland. *Trembley.*—Belgium. *Dumortier* and *Van Beneden.*

When removed from the water, *L. crystallinus* appears immersed in a transparent gelatinous investment which envelopes the entire colony, leaving only the orifices free. This investment, which, as has been already shown,* is really a delicate transparent membrane filled with a fluid and representing the ectocyst, may be easily removed; and, indeed, specimens kept for some time in confinement may often be found quite freed from it. I cannot help thinking that the specimens observed by M. Van Beneden, and described by this naturalist as destitute of the investment in question, were only accidentally in this state, which I believe is never presented by freshly captured, healthy individuals.

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* Vide *supra*, p. 14.

Full-grown specimens have the endocyst deeply lobed, so as to cause it to present a kind of palmate appearance. The intervals of the lobes, however, are nearly filled by the gelatinoid ectocyst. Young specimens are not lobed, and then they correspond to the "Bell-flower Animal" of Baker.

Both Baker and Van Beneden ascribe to this animal a power of locomotion. To the existence of this power, however, my own observations are opposed; the colony is certainly very easily detached, and will when all is quiet again readily fix itself, so that a passive change of place may in this way be effected; but though I have had numerous specimens constantly under my eyes, I have never witnessed anything like the active locomotion of *Cristatella*.

The ectocyst is perfectly colourless and transparent, the endocyst and polypides are pale brownish-yellow.

The statoblasts are larger than those of any other fresh-water Polyzoon, except *Cristatella*. They are of an elliptical form, with the long diameter prolonged at each extremity into a short acute point.

L. crystallinus is one of the largest of the Polyzoa, and this circumstance, together with the transparency of the cœnœcium, renders it peculiarly well adapted for examining the structure of the class.

In many cases the perigastric space in *Lophopus* was found to contain numerous spherical bodies (Pl. II, figs. 16—23), which floated freely in the perigastric fluid, where they were rapidly whirled about under the influence of the currents. They varied much in size, some being about the $\frac{1}{1500}$ of an inch in diameter, while others were as large as an ordinary *Volvox globator*. Some were seen to consist in a spherical transparent cell, with nearly colourless granular contents, involving numerous minute spherical bodies, apparently young cells; these contents were aggregated on the inner surface of the wall, where they constituted a thick, somewhat irregular layer. In other cases the contents were seen to be entirely resolved into a brood of young cells, which completely filled the parent-cell; while in the largest individuals these secondary cells might themselves be seen in various stages of growth and subdivision, some presenting the appearance of a little spherical granular mass with visible nucleus, but without distinct cell-wall, others somewhat larger, with the cell-wall become distinct, and others in which the granular contents had retired from the cell-wall towards the centre of the cell, where they were to be seen surrounded by a colourless fluid. In a still further stage the contents had become divided into two masses, while in still more advanced cases each of these masses might be seen again dividing into two others, the subdivision being preceded by the appearance of two nuclei in each mass. The whole of this brood of young cells was ultimately liberated by the rupture of the large parent-cell, and then floated away in the perigastric fluid.

That the bodies now described had no necessary connection with the Polyzoon in whose interior they occurred, must, I think, be admitted; their presence is, without doubt, purely parasitical.

Genus IV. ALCYONELLA, *Lamarck*, 1816.

Name.—A diminutive noun, formed from *Alcyonium*, a genus of marine Actinozoal Radiata.

The animal originally described by Pallas, under the name of *Tubularia fungosa*, and by Bruguière under that of *Alcyonium fluviatile*, was assumed by Lamarck as the type of a new genus which he named *Alcyonella;* but, deriving its characters from the very incorrect description and figures of Bruguière, Lamarck's definition of the genus is necessarily erroneous,

Some naturalists insist on the identity of the genera *Alcyonella* and *Plumatella*, and go so far as to maintain that the animal described under different names, by Pallas, Bruguière, and Lamarck, possesses no essential character to distinguish it even specifically from *P. repens* or *P. campanulata*, the difference being solely the result of accidental causes—especially the form and size of the object to which it is attached—operating on it during its growth, and thus influencing its development. The author who has most elaborately defended this view is M. Raspail, and a similar opinion has been advocated by Ehrenberg and Siebold. After, however, much attention to the subject, I have satisfied myself that there are sufficient grounds for keeping the two groups generically distinct. It is quite true that, in its young state, *Alcyonella* has its tubes distinct, creeping along the surface of the supporting body, and in this condition, I admit that it cannot be distinguished from a *Plumatella*, but it is only in its early youth that it presents this form. *Plumatella*, on the other hand, preserves a distinctness of its tubes throughout its whole existence. I have found very large specimens of *Plumatella* under precisely the same circumstances as those in which we meet *Alcyonella*, and yet without the slightest tendency to assume the form of the latter genus. Another argument, which strongly supports the view here taken, is derived from the fact that *Alcyonella* has not yet been detected in Ireland,* though *Plumatella repens* is exceedingly abundant throughout the island, frequently presenting the utmost luxuriance, and yet invariably preserving a total distinctness of its tubes, no matter what the form or size of the object on which it grows.

In distinguishing the species of *Alcyonella*, I have employed characters drawn chiefly from the general habit of the animal, the structure of the cœnœcium, and the shape of the statoblasts. We have seen, in the anatomical section of this monograph,† that the ectocyst in the genera *Alcyonella* and *Plumatella* sometimes presents upon its surface the appearance of a transparent longitudinal furrow running along the length of each tube, commencing in the vicinity of the orifice as a triangular notch-like space, and passing into a prominent keel as it recedes from this point. The presence of the longitudinal furrow constitutes an important specific character, and its value is enhanced by its being of easy application; it occurs in two out of the three species of *Alcyonella*.

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* In my Synopsis, published in the 'Annals of Natural History,' 1844, I recorded *Alcyonella stagnorum* as a native of Ireland. The animal, however, there alluded to under this name is really the *Polype à Panache;* and I was led into this error from adopting at that time the opinion of Raspail, Johnston, and other naturalists, that Trembley's animal was identical with the *A. stagnorum* of Lamarck.

† Vide *supra*, p. 13.

Another very valuable character is obtained from the shape of the statoblasts. The ordinary or free statoblasts, both in *Alcyonella* and *Plumatella*, present two different shapes; in some species they are broadly elliptical, the diameters of the ellipse being to one another pretty nearly in the ratio of 2 : 3; in others again they are narrow, the diameters being nearly as 1 : 2. The terms *broad* and *elongated* therefore, as applied to the ova in the following diagnosis, are to be understood as expressing this difference of shape.

Generic character.—Cœnœcium composed of membrano-corneous branched tubes, which adhere to one another by their sides; orifices terminal. Statoblasts elliptical, with an annulus but without marginal spines.

Number of known species three.

1. *Alcyonella fungosa*, Pallas. Pl. III.

Specific character.—Cœnœcium fungoid, formed of numerous branched vertical tubes destitute of a furrow. Statoblasts broad.

SYNONYMS.—1768. *Tubularia fungosa.* Pallas, Descript. Tub. Fung. Nov. Comment. Acad. Sci. Imp. Petropol. tom. xii, p. 565, tab. 14. (Original figures.)
1782. *Spongia lacustris.* Schmiedel, Icones Plantarum et Anal. Partium.
1786. *Leucophra heteroclita.* Müller, Animal. Infusor. p. 158, tab. 22, fig. 27-34. (Locomotive embryo, original figures.)
1789. *Alcyonium fluviatile.* Bruguière, Encyc. Méth. 1789, p. 24, pl. 472, fig. 3. (Original figure, bad.)
1802. *Alcyonium fluviatile.* Bosc. Vers. vol. iii, p. 132.
1816. *Alcyonium fluviatile.* Lamouroux, Pol. flex. p. 354.
1816. *Alcyonella stagnorum.* Lamarck, An. sans Vert. 1st edit. vol. ii, p. 102.
1820. *Alcyonella stagnorum.* Schweigger, Handbuch der Naturg. p. 423.
1821. *Alcyonella stagnorum.* Lamouroux, Exposit. Méth. p. 71, tab. 76, fig. 5-8. (Figures copied from Bruguière.)
1824. *Alcyonella stagnorum.* Lamouroux, Enc. Méth. 1824, Zooph. p. 38.
1828. *Alcyonella fluviatilis* vel *A. ultimus evolutionis gradus.* Raspail, Hist. Nat. de l'Alcyonelle fluv., Mém. de la Soc. d'Hist. Nat. de Paris, tom. iv, p. 130, pl. 12-16. (Original figures.)
1828. *Alcyonella stagnorum.* Meyen, Isis, tom. xxi, p. 1225, pl. 14. (Original figures.)
1831. *Alcyonella stagnorum.* Ehrenberg, Symbolæ Physicæ Evert. Dec. 1, Pol. fol. *a*.
1834. *Alcyonella stagnorum.* Blainville, Man. d'Actin. p. 491, pl. 85, fig. 8. (Figure copied from Raspail.)

1835. *Alcyonella stagnorum.* Carus, Tabulæ Illustrantes, pars 3, tom. 1. (Figure locomotive embryo, copied from Meyen.)
1836. *Alcyonella stagnorum.* Dumortier, Mém. sur les Pol. comp. d'eau douce, p. 24.
1836. *Alcyonella stagnorum.* Lamarck, An. sans Vert., 2d edit., vol. ii., p. 116.
1837. *Alcyonella stagnorum.* Teale, Trans. Phil. and Liter. Soc. of Leeds, vol. i, part 1, p. 116, pl. 12. (Original figure.)
1837. *Plumatella campanulata*, var. *B. dumetosa.* Gervais, Ann. Sc. Nat., 1837, p. 78.
1838. *Alcyonella stagnorum.* Johnston, Hist. Brit. Zooph., 1st edit., p. 311, pl. 45. (Figures partly original, and partly copied from Raspail.)
1839. *Alcyonella fluviatilis.* Gervais, Ann. Franc. et Etrang. d'Act., tom. iii, p. 135.
1839. *Alcyonella.* Van Beneden. Bull. de l'Acad. de Brux., tom. vi, part 2, p. 276, figs. 3, 3'. (Original figures.)
1840. *Alcyonella fluviatilis.* Gervais, Dict. Sci. Nat. Suppl. art. *Alcyonelle.* (Original figures.)
1847. *Alcyonella stagnorum.* Johnston, Brit. Zooph. 2d edit. p. 391, pl. 74. (Figures partly original, partly copied from Raspail.)
1848. *Alcyonella stagnorum.* Siebold, Lehrbuch der Vergleich. Anat., § 38. note 1; § 40, note 2; § 43, note 4.
1848. *Alcyonella fungosa.* Van Beneden, Recherch. sur les Bryoz. fluv. de Belg., p. 18, Mém. de l'Acad. Roy. de Belg., 1848.
1848. *Alcyonella fungosa.* Dumortier et Van Beneden, Hist. Nat. des Pol. comp. d'eau douce, Mém. servant de complément au tom. xvi des Mém. de l'Acad. Roy. des Sci. de Brux. (Original figures.)
1849. *Alcyonella anceps.* Dalyell, Rare and Remark. Anim. of Scotland, vol. ii. (Original figures.)
1849. *Alcyonella gelatinosa.* Dalyell, Rare and Remark. Anim. of Scotland, vol. ii. (Original figures.)
Alcyonella fungosa. Allman, Proc. Roy. Irish Acad., vol. iv, p. 470.

Iconography.—The original figures are those of Pallas, Müller (embryo), Bruguière, Schmiedel, Raspail, Meyen, Teale, Johnston, Van Beneden (Bull. de l'Acad. de Brux., 1839), Van Beneden (Mém. de l'Acad. de Brux., 1848), Dumortier and Van Beneden (Hist. Nat. des Pol. Comp.), Dalyell.

HABITAT.—Stagnant and slowly running waters, canals, &c., attaching itself to stones, floating timber, and submerged branches of trees; loving obscure places.

LOCALITIES.—*British:* Regent's Canal, London, attached to the sides of the docks, abundant; Chelmar Canal, Essex, abundant. *G. J. A.*—London and East India Docks, on the Thames, attached to floating timber, abundant. *Mr. Busk, Mr. Quekett, Mr. Bowerbank*, and *G. J. A.*—In brackish water, near Ipswich. *Mr. Wigham.*—Near Leeds. *Mr. Mathewman.*—Berwickshire. *Sir J. Graham Dalyell.*—It is, probably, generally distributed through England. No Irish locality.

Foreign.—France. *Bruguière, Raspail, Gervais.*—Belgium. *Van Beneden* (Bull. de l'Acad. de Brux.) *Dumortier* and *Van Beneden* (Hist. Nat. des Pol. comp.)—Germany, *Meyen.*—Russia. *Pallas.*

Alcyonella fungosa presents itself in the form of brown fungoid masses of very variable size and shape, attached to the surface of different fixed objects, as stones, pieces of wood, fresh-water shells, &c. The masses frequently acquire a considerable size, weighing upwards of a pound. They are often irregularly lobed, and when they grow upon the surface of a cylindrical body, as a twig on the stem of some aquatic plant, usually surround it so as to assume a somewhat spindle-shaped figure, gradually diminishing in thickness from the centre towards the extremities. They are fond of attaching themselves to the branches of trees which dip into the water, and then constantly exhibit lobed, pear-shaped masses pendant from the extremities of the sprays.

When a living specimen is examined in the water, its whole surface seems covered with a whitish down, which a slight examination shows to be occasioned by the protrusion of innumerable polypides. When removed from the water, the polypides shrink back into their cells, and the surface then seems covered with a gelatinous investment, caused by the soft, papilla-like, extremities of the tubes. These extremities contract no adhesion to one another, like the rest of the tubes, and the ectocyst, as it passes over them, becomes very delicate and transparent; in dead specimens they shrivel up and disappear, and then the surface of the mass presents a multitude of closely applied hexagonal or pentagonal orifices. The whole production now assumes the appearance of a spongy, honeycomb-like mass, and this has not unfrequently been mistaken for a fresh-water sponge. A vertical section shows it to be composed of a vast number of tough, membrano-corneous-branched tubes, closely adherent to one another, and each opening on the surface by one of the angular orifices, just mentioned. Imperfect transverse septa may be seen at the origin of many of the branches. The tubes, towards the end of summer, are loaded with mature statoblasts, which, on the rupture of the cœnœcium, escape in great numbers into the surrounding water.

The colour of the living mass varies somewhat with the nature of the food and the state of depletion at the time, the contents of the stomach being visible through the transparent portion of the tubes. When the stomach is not filled with food, so as to impart an adventitious colour to the mass, the latter is generally of a light-brown, or gray, upon the surface, and of a darker brown in section. It is in perfection during the summer and autumn; in winter, nothing is to be found of it but the empty and decaying cœnœcium.

A. fungosa is a widely distributed Polyzoon, having been found in Russia, France, Prussia, Belgium, and the British Isles. It is curious enough that, though it is common in England and Scotland, it has never yet been found in Ireland, where all the other British genera are abundant. It prefers stagnant and slowly running waters. Some of the largest specimens I have seen were in the Chelmar, a sluggish river in the county of Essex, which has been widened and deepened into a canal, for the purposes of inland navigation.

2. *Alcyonella Benedeni*, Allman. Pl. IV, figs. 5—11.

Specific character.—Cœnœcium fungoid; formed of numerous branched vertical tubes, which are emarginate at the orifice, and furnished with a furrow. (Free) Statoblasts elongated.

SYNONYM.—1850. *Alcyonella Benedeni.* Allman, British Association Report.

Iconography.—No published figure.

Habitat.—Stagnant waters. Same as that of *A. fungosa.*

Locality.—Chelmar Canal, Essex. *G. J. A.*

The present well-marked species I have great pleasure in dedicating to M. Van Beneden, a naturalist who has not only done more than any one else in the particular department to which this monograph is devoted, but who has enriched our knowledge of the lower animals generally, by contributions numerous and valuable.

A. Benedeni occurs in spongy masses attached to twigs, and other fixed bodies, and resembling *A. fungosa* in their general appearance. They would seem, however, never to attain to so large a size as the latter, the largest specimens I have seen, measuring about three inches in length, and an inch in thickness at the thickest part. The tubes are closely adherent to one another until within a short distance of their terminations, when they become free. The ectocyst is dark brown, becoming rather abruptly lighter in the vicinity of the orifices, where the peculiar characteristic furrow commences by a triangular notch-like space, and then passing down as a narrow slit-like line, is finally lost where the adhesion of the tubes begins. When withdrawn from the water, the tubes seem terminated by a little papilliform body, formed by the endocyst, over which the ectocyst is continued as a very delicate, transparent, and colourless membrane. In extreme retraction, the papilliform terminations are entirely withdrawn into the remainder of the tube.

The statoblasts are of two kinds—free, and adherent. The free statoblasts are narrowly elliptical, approaching to bean-shaped; the disc is brown, minutely mamillated; the annulus is dull yellow, widely overlapping the disc, especially on the more convex side. These statoblasts are found in immense numbers towards the end of summer, lying quite free in the interior of the tubes, and, on the rupture of the latter, escape, and instantly rise to the surface of the water. Besides these bodies, others much less numerous are also found in the present species, but are always attached to the inner walls of the tubes. They are broadly elliptical, enclosed in a pergamentaceous shell, like the free statoblasts, but with a very narrow margin.* Of their real import we are ignorant.

I have met with *A. Benedeni* only in one locality, namely, the River Chelmar, in Essex, where it existed in abundance, along with *A. fungosa* and the following species:

3. *Alcyonella flabellum*, Van Beneden. Pl. IV, figs. 1—4.

Specific character.—Cœnœcium flabelliform, composed of branched prostrate tubes, furnished with a furrow. Statoblasts broad.

Synonyms.—1848. *Alcyonella flabellum.* Van Beneden, Recherches sur les Bryozoaires fluv. de Belg., p. 19; Mém. de l'Acad. Roy. de Belg., 1848. (Original figures.)
1850. *Alcyonella flabellum.* Allman, Proc. Roy. Irish Acad., vol. iv, p. 470.

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* Vide *supra*, p. 40.

Iconography.—The original figures of Van Beneden.

Habitat.—Stagnant and slowly running waters, adhering to the submerged stems of aquatic plants.

Localities.—*British:* Chelmar Canal, Essex. *G. J. A.*—Reading. *Mr. Bowerbank.*
Foreign: Belgium. *Van Beneden.*

This species was first characterised by M. Van Beneden, who discovered it in Belgium, and described it in the 'Memoirs of the Royal Academy of Belgium,' for the year 1848. In September, 1849, I received from Mr. Bowerbank a living specimen, obtained in the neighbourhood of Reading; it was attached to a decayed twig, along with *A. fungosa*, and had developed itself in the form of two flabelliform masses, attached to one another by a short simple tube, as figured by Van Beneden. In July of the following year, I met with the same species in the River Chelmar, attached to the petioles and under surface of the leaves of *Nymphæa alba.*

A. flabellum is a small, but very pretty Polyzoon, and rendered very striking by its mode of growth in two flabelliform fasciculi of tubes, each fasciculus closely adherent by one face to the surface of the body on which it is developed. The largest specimens I have met with measure about half an inch in their longest direction. The ectocyst is dark brown, becoming abruptly lighter towards the orifices; the furrow, commencing wide in the vicinity of the orifices, extends as a narrow transparent line along the free surface of the tubes, giving them the appearance of being slit along one side.

The polypides have about forty tentacula, and the margin of the calyciform membrane is distinctly festooned.

I have not observed the statoblasts, as these bodies were not present in any of the specimens I examined; they are, however, figured and described by Van Beneden as broadly elliptical.

Genus V. PLUMATELLA, *Lamarck*, 1816.

Name.—A diminutive noun, formed from *pluma*, a feather, in allusion to its plume-like crown of tentacles.

When Vaucher, in 1804, added, under the name of *Tubularia lucifuga*, a supposed new species of fresh-water Polyzoa to those previously known, all these animals, with the exception of the *Alcyonium fluviatile* of Bruguière, and the *Kleiner Federbusch Polyp* of Rösel, for which Cuvier had constituted a genus under the name of *Cristatella*, were placed in the genus *Tubularia*, along with numerous marine polypes of a totally different organization. The unzoological nature of this association was apparent to Bosc, who, in 1804, pointed out the necessity of viewing the so-called *Tubularias* of fresh water as a distinct generic group, of which he gave the characteristics, but which he neglected to name, and it was reserved for Lamarck, by naming Bosc's genus, to confer on it a fixed and definite place in our systems. The name of *Plumatella* was that which Lamark gave to this group, but as it included the "Polype à Panache," a polyzoon whose organization does not admit of a generic association with the others, it has since been found necessary to restrict the genus *Plumatella* as established by Bosc and Lamarck, and to constitute a separate genus for the "Polype à Panache."

Except in the condition of the dermal system, the structure of *Plumatella* differs in no essential point from that of *Alcyonella*. This system, however, in the coalescence of the tubes into a common mass in *Alcyonella*, while they remain totally distinct in *Plumatella*, presents us with a difference which I believe to be of sufficient importance to justify us in placing the two forms in separate generic groups.*

The cœnœcium in *Plumatella* consists essentially of a linear, more or less branched series of tubular cells of membrano-corneous consistence, each springing from its predecessor, and constituting a short ramulus, which is terminated by the orifice destined for the egress of the polypides. In some species the cells are nearly cylindrical, in others they are claviform, and when the latter figure occurs, especially in connection with short cells, a more or less moniliform, or concatenated appearance is presented by the cœnœcium. In most of the species, perhaps in all, transverse septa or diaphragms occur near the origin of certain cells when complete, separating the cavities of these cells from those of the neighbouring ones. They, however, are very frequently incomplete, admitting of a free communication between neighbouring cells, and in many cells are even totally absent. In some species they occur at distant and irregular intervals, and may be easily overlooked, while in others (*P. coralloides*) they exist with almost as much regularity and completeness as in *Paludicella*. The first instance in which I became aware of the existence of these septa was in *Plumatella coralloides*, where they occur with singular regularity and distinctness. So striking, indeed, was the character thus presented, that I thought it of sufficient importance to entitle this species to the rank of a distinct genus. Further investigation, however, rendered apparent the presence of similar septa in other species, but occurring frequently at such distant intervals in the tubes, and with so much irregularity, as to deprive this character of that importance which one would feel at first inclined to attribute to it. Indeed, the tendency to the formation of transverse septa would seem to occur generally throughout *Alcyonella*, *Plumatella*, and *Fredericella*, while in *Paludicella* these septa acquire their maximum in development and constancy, and become thus one of the most striking features of the Polyzoon.

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* See above, p. 86.

In drawing out the diagnoses of the species of *Plumatella*, I have availed myself of the same class of characters as those which were used for a similar purpose in *Alcyonella*, namely, the general habit of the animal, the presence or absence of the furrow in the ectocyst, and the shape of the statoblasts. The number of the tentacula also, and the more or less plicated or festooned condition of the edge of the calyciform membrane are generally introduced into the specific character. It must be recollected, however, that unless the difference in the number of tentacula amounts to ten or fifteen, it can scarcely be relied on as a specific character, and the condition of the calyx, though perhaps really of sufficient constancy to form a good character, is often very difficult to determine. These last two characters can in general, therefore, only be considered as of secondary value, and merely adjuvant to the former.

Generic character.—Cœnœcium confervoid, branched, composed of a series of membrano-corneous tubular cells, each of which constitutes a short ramulus with a terminal orifice; branches distinct from one another. Lophophore crescentic. Statoblasts elliptical, with an annulus, but without marginal spines.

Number of known species twelve, of which nine are British.

1. *Plumatella repens*, Linnæus. Pl. V.

Specific character.—Cœnœcium irregularly branched, cells sub-claviform, destitute of furrow and keel. Tentacula about sixty; margin of calyx distinctly festooned. Statoblasts broad.

Variation α.—Cœnœcium closely adherent, creeping along the surface of various submerged bodies, to which the branches are attached in their entire length. (Pl. V, figs. 1, 2.)

Variation β.—Cœnœcium attached only towards the origin, branches soon becoming free. (Pl. V, figs. 3, 4.)

SYNONYMS.

It is scarcely possible to conceive of a species burdened with a more discordant and perplexing synonymy than that which encumbers the history of *P. repens*. In order to reduce this chaos to some sort of order, the first step is, of course, the determination of the exact animal which the original founder of the name had in view in his description.

In the tenth edition of the 'Systema Naturæ," published in 1758, we find Linnæus introducing an animal under the name of *Tubipora repens*, and placing it amongst his *Lithophyta* with the following diagnosis:

"T. corallio repente filiformi dichotomo: tubis flexilibus cylindricis distantibus erectis.

"Habitat in aquæ dulcis plantis in Nymphæa, &c., minuta."

The figures here referred to are Trembley's "Polype à Panache," as copied by Bæck in 'Acta Suecica,' Rösel's figures of his "Federbusch-Polyp," and Schäffer's figures of his

"Corallenartiger Kamm-Polyp." a reference so discordant as to render it very difficult to determine the animal Linnæus had in view in his *Tubipora repens.* Linnæus's short description, however, plainly excludes the "Polype à Panache;" and that the original of the *Tubipora repens* was really Schäffer's animal seems confirmed by the 'Fauna Suecica,' published in 1761, where *Tubipora repens* is also given, but with Schäffer's animal quoted as the only synonym.

In the twelfth edition of the 'Systema Naturæ,' published in 1767, *Tubipora repens* is altogether omitted; but in this edition a new species is introduced under the name of *Tubularia campanulata,* with the following short diagnosis:

"T. reptans tubis campanulatis."

The animal thus defined is without any doubt the "Polype à Panache" of Trembley, though to the real synonyms of the "Polype à Panache" there is added "Schäffer, tab. 1, fig. 9." The *Tubularia campanulata* is intended to replace the *Hydra campanulata* of the tenth edition, which however, as there described, is certainly an imaginary species, founded on the fifth and sixth figures of Bæck's plate in the 'Acta Suecica,' which are evidently drawn from some animal very imperfectly observed, though most probably intended for the "Polype à Panache."

In 1773 we find O. F. Müller giving the name of *Tubularia repens* to a polyzoon which he found in the fresh waters in Denmark, and which he viewed as identical with Schäffer's "Kamm-polyp." If Müller be correct in this view—and there is certainly every reason to think he is—the true synonyms of the *Tubularia repens* of Müller will be *Tubipora repens,* Linnæus, and "Corallenartiger Kamm-polyp," Schäffer.

It is evident that Linnæus had a very imperfect idea of his *Tubipora repens,* but we are now happily no longer left in doubt as to the nature of the animal in question; for though both Schäffer's and Linnæus's descriptions are very meager, Müller's, on the contrary, is full and perspicuous, though unfortunately not accompanied by an original figure; so that we are compelled to have recourse to the figures of Schäffer, to which Müller refers us, and which, though very imperfect, would seem sufficient for the purposes of identification; one represents a small portion of the cœnœcium of the natual size creeping spirally round the stem of some aquatic plant; the other is a portion magnified, with three polypides in three different states of exsertion.

From this time we find writers relying almost exclusively on the description of Müller, and after some notices of minor importance by different authors, we find the name given by Müller introduced into the 'Systema Naturæ' by Gmelin, who in his edition of this great work, published in 1789, makes mention of the *Tubularia repens* with Müller's diagnosis.

In 1804 a new element of confusion was introduced into the synonymy of this species by Vaucher, who mentions the occurrence of *Tubularia repens,* and adds incidentally, that its ova are *elongated:* this naturalist accompanies his notice with a figure, which, however, in no respect agrees with Müller's description; and I have no hesitation in considering the animal which Vaucher, under the belief that it was the same as that described by Müller, calls *Tubularia repens,* to be quite distinct from this species; it comes nearer to *Plumatella emarginata* of the present monograph; and indeed, were it possible from Vaucher's data to form any opinion of value on this subject, I should not be disinclined to view it as identical with the latter, though the description and figures of Vaucher are so very imperfect as to render it impossible to decide with satisfaction on his species. The *T. lucifuga* of Vaucher on the other hand, comes much nearer to the true *Tubularia repens*, and is probably identical with it, for the number of tentacula which he ascribes to the species is evidently the result of having observed the polypide in a very partially exserted state, and therefore goes for nothing in the description.

We next find Müller's *Tubularia repens* enumerated by Turton in his edition of the 'Systema Naturæ,' 1806. In 1816 we have Lamarck substituting the generic name of *Plumatella* for that of *Tubularia*, as applied to the fresh-water Polyzoa, and describing, under the name of *Plumatella repens*, an animal for which he adduces Schäffer's figure, but which he characterises from the erroneous description and figures of Vaucher; the *P. repens* of Lamarck, therefore, while it must be viewed as synonymous with Vaucher's *Tubularia repens*, can find no place in the synonymy of the true *Tubularia repens* of Müller. Lamouroux, first in 1816 (Pol. Flex.), and afterwards in 1821 (Exp. Méth.), substitutes the name of *Naisa repens* for *Tubularia repens*, employing Müller's diagnosis, though referring to Vaucher, and in the latter work reproducing his figure. De Blainville, in 1834, enumerates without any diagnosis *Plumatella repens*, quoting as synonyms the *Tubularia repens* both of Gmelin (Syst. Nat.) and Vaucher. Gervais, in 'Ann. Franç. et Etrang. d'Anat.,' 1839, enumerates also without description the *Plumatella repens*, quoting among his synonyms not only Schäffer and Müller, but also Vaucher. The *Plumatella repens* of Johnston (Brit. Zooph. edit. 1 and 2, 1838 and 1847) is the true animal of Schäffer and Müller. Lastly, Van Beneden (Recherches sur les Bryozoaires fluviatiles, 1848) describes, under the name of *Plumatella repens*, a Polyzoon which I cannot safely refer to the original *Tubularia repens*; Müller's character, "Tubuli basi angustati apice crassiores," does not at all agree with it, while the elongated ova approach it to Vaucher's *Tubularia repens*, and to the *Plumatella emarginata* of this monograph and of my Synopsis, published in the 'Annals and Magazine of Natural History,' 1844, from which, however, it is separated by the absence of a furrow. The *Plumatella campanulata*, on the contrary, of Van Beneden is doubtless identical with the true *Tubularia repens* of the Danish naturalist, and with the animal here described under the name of *Plumatella repens* var. *α*.

While the "Corallenartiger Kamm-polyp" of Schäffer thus formed the basis of the various synonyms now enumerated, the animal described by Rösel (Insecten Belustigung, 1755) under the name of "Federbusch-polyp," was made the basis of another series of synonyms. This Polyzoon was first systematically named by Pallas, who described it in his 'Elenchus,' published in 1766, giving to it the name of *Tubularia gelatinosa*. We afterwards find Blumenbach (Handbuch der Naturg. 1777) describing it under the name of *Tubularia campanulata*, with the following diagnosis, which is evidently formed from the incorrect account given by Rösel:—

"T. crista lunata orificiis vaginæ annulatis corpore intra vaginam abscondito."

Next comes Gmelin ('Syst. Nat.' 1789), who also describes it, employing both the name and diagnosis of Blumenbach. We have already seen that the *Tubularia campanulata* of the 'Systema Naturæ,' 1767, was a totally different animal, namely the "Polype à Panache" of Trembley. Rösel's animal is next described in Dr. Turton's edition of the 'Systema Naturæ,' 1806, under the name of *Tubularia reptans*, the *Tubularia campanulata* of this edition being the same as that of the edition of 1767. From this time forwards, the specific name *campa-*

nulata continued to be employed by the greater number of naturalists for Rösel's Federbusch-polyp, and we find accordingly this little animal so designated by Lamarck, De Blainville, Dumortier, and Gervais.

The next question of importance is the determination of the exact relation which the two series of synonyms just enumerated hold to one another. In order to form an accurate opinion on this point, it will be necessary to bear in mind the two variations α and β, which *P. repens* has been just described as presenting. Now, I believe, the "Corallenartiger-Kamm-polyp" of Schäffer to correspond to the *P. repens* var. α of this monograph, while the "Federbusch-polyp" of Rösel corresponds to the variation β, and if so, the two animals must be viewed as identical in species. Müller believed them to be distinct, but he founded this opinion on certain characters in the figures and description of Rösel, some of which were obviously erroneous, while others afforded no grounds for specific distinction at all. The distinction, therefore, drawn by Müller is nugatory, and the specific name *campanulata*, applied by Blumenbach to Rösel's animal, and adopted by subsequent writers, is applicable to no distinct species, and must therefore be expunged.

If the above criticism be admitted—and it is what I have arrived at after a very laborious examination—the synonyms of *P. repens* will stand thus:—

Variation α.

1754. *Corallenartiger Kamm-polyp.* Schäffer, Armpolypen, tab. 1, figs. 1, 2. (Original figures.)
1758. *Tubipora repens.* Linnæus, Syst. Nat., edit. x.
1761. *Tubipora repens.* Linnæus, Fauna Suecica, 2219.
1773. *Tubularia repens.* Müller, Verm. ter. et fluv., vol. i, pars 2, p. 16.
1776. *Tubularia repens.* Müller, Zool. Dan. Prod., 3064.
1781. *Der polyp mit dem Feder-busch.* Eichorn, Naturg. der Kleinst. Wasser-thiere, tab. 4. (Original figure.)
1789. *Tubularia repens.* Gmelin, Linn. Syst. Nat., p. 3835.
1804. *Tubularia lucifuga?* Vaucher, Bull. de la Soc. Philomat., ann. xii, No. 81, pl. 19, figs. 4, 5, 6, 7, 8.* (Original figures, bad.)
1806. *Tubularia repens.* Turton, Linn. Syst. Nat., vol. iv, p. 668.
1816. *Plumatella lucifuga?* Lamark, An. sans Vert., 1st edit., vol. ii, p. 108.
1816. *Naisa repens.* Lamouroux, Pol. flex. p. 223.
1821. *Naisa repens.* Lamouroux, Expos. Méth., p. 16. (Not the figure tab. 68, f. 2, which is a copy of Vaucher's *Tubularia repens.*)
1824. *Naisa lucifuga?* Deslongchamps, Encyc. Méth. Zoophytes, p. 562.
1826. *Plumatella lucifuga?* Blainville, Dict. Sc. Nat., tom. xlii, p. 12.
1826. *Plumatella calcaria?* Carus, Tabulæ Illustrantes. (Original figure.)
1828. *Alcyonella, tertius evolutionis gradus.* Raspail, Mém. de la Soc. d'Hist. Nat. de Paris, vol. iv, p. 130.
1831. *Alcyonella stagnorum.* Ehrenberg, Symb. Phys. Evert. Dec. 1, Pol., fol. *a.*

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* Figs. 9 and 10 evidently belong to *T. repens* on the same Plate, and are transposed by an error of the engraver, while figs. 4 and 5 belong to *T. lucifuga*, though by a similar error they are placed with *T. repens.*

1834. *Plumatella repens.*
1834. *Plumatella lucifuga.* } Blainville, Actinologie, p. 490.
1836. *Plumatella lucifuga?* Lamarck, An. sans Vert. 2d edit., vol. ii, p. 124.
1836. *Plumatella repens.* Dumortier, Mém. sur les Pol. comp. d'eau douce, p. 21.
1838. *Plumatella repens.* Johnston, Brit. Zooph., 1st edit., p. 322, fig. 51, p. 332. (Original figure.)
1839. *Plumatella repens.* Gervais, Ann. Franç. et Etrang. d'Anat., tom. iii, p. 134.
1842. *Plumatella repens.* Allman, Proc. Roy. Irish Acad., No. 38.
1843. *Plumatella repens, first variation.* Allman, Rep. Brit. Assoc., Trans. of Sections, p. 74.
1843. *Plumatella repens.* Thompson, Rep. Brit. Assoc., p. 285.
1844. *Plumatella repens.* Allman, Ann. Nat. Hist., vol. xii, p. 330.
1847. *Plumatella repens.* Johnston, Brit. Zooph., 2d edit., p. 402, fig. 76, p. 403. (Original figure.)
1848. *Plumatella campanulata.* Van Beneden, Recherches sur les Bryoz. fluv., p. 20, pl. 1, figs. 5, 6, 7, Mém. de l'Acad. Roy. de Belg. (Original figures.)
1849. *Plumatella repens.* Dalyell, Rare and Remark. Anim. of Scotland, vol. ii. (Original figures.)
1851. *Plumatella nitida?* Leidy, Proc. Acad. Nat. Sci. of Philadelphia, vol. v, p. 321.

Iconography.—The original figures of *P. repens α*, are those of Schäffer, Eichhorn, Vaucher, Raspail, Carus, Johnston, Brit. Zooph. 1st edit., Johnston, Brit. Zooph. 2d edit., Van Beneden and Dalyell.

Variation β.

1755. *Federbusch-polyp.* Rösel, Insect. Belustig. Supp., p. 447. tab. 73, 74, 75. (Original figures.)
1766. *La première sorte de Polypes à Bouquet.* Ledermuller, Amus. Micros. 2^me cinq., p. 94, tab. 87. (Figures imperfect copies from Rösel.)
1766. *Tubularia gelatinosa.* Pallas, Elenchus Zooph., p. 85.
1777. *Tubularia campanulata.* Blumenbach, Handbuch der Naturgeschichte.
1789. *Tubularia campanulata.* Gmelin, Linn. Syst. Nat., 3834.
1806. *Tubularia reptans.* Turton, Linn. Syst. Nat., vol. iv, p. 669.
1816. *Plumatella campanulata.* Lamarck, Ann. sans Vert., 1st edit., vol. ii, p. 108.
1816. *Naisa campanulata.* Lamouroux, Hist. des Pol. flex., p. 224.
1820. *Plumatella campanulata.* Schweigger, Handbuch der Naturg., § 76.
1824. *Naisa campanulata.* Deslongchamps, Encyc. Méth., Zooph., p. 562.
1826. *Plumatella campanulata.* Blainville, Dict. Sc. Nat., vol. xlii, p. 12.
1826. *Plumatella campanulata.* Risso, Hist. Nat. de l'Europe Méridion., vol. v, p. 308.
1834. *Plumatella campanulata.* Blainville, Actinologie, p. 490, pl. 85, fig. 6. (Figure copied from Rösel.)
1835. *Lophopus campanulatus?* Dumortier, Bull. Ac. Brux., p. 424.
1836. *Plumatella campanulata.* Lamarck, Ann. sans Vert., 2d edit., vol. ii, p. 123.
1837. *Plumatella campanulata.* Gervais, Ann. Sc. Nat., 2d series, tom. vii, p. 78.

Bayerische Staatsbibliothek München

1839. *Plumatella campanulata.* Gervais, Ann. Franç. et Etrang. d'Anat., tom. iii, p. 134.

1848. *Plumatella repens, second variation.* Allman, Rep. Brit. Assoc., Trans. of Sect., p. 74.

Iconography.—The only original figure of this variation is that of Rösel.

HABITAT.—In lakes and ponds, and in rivulets of moderate rapidity, attached to the under surface of stones, and to the stems of aquatic plants, and under side of floating leaves, avoiding the light.

LOCALITIES.—*British:* Generally distributed throughout England and Ireland, in some places very abundant. In Scotland it occurs as far north as the Orkneys, whence I have obtained specimens from Lieutenant Thomas, who collected them there in Bea Loch, Sanda; it is probably generally distributed through Scotland, having been met with there in various localities by Dr. Fleming, Sir J. G. Dalyell, and myself.

Foreign: Among continental localities, may be mentioned Lake of Lucerne, Lago di Como, in both of which I obtained it during the summer of 1854; the Alpine lakes, Lac Seculejo and Lac d'Aul in the Pyrenees, where I obtained it in the autumn of 1856; in the former at an elevation of 4590 feet, and in the latter at about 6500 feet above the level of the sea. It has been met with also in other parts of France and Italy, as well as in Belgium, Germany, Prussia, Sweden, and Denmark, as recorded by Raspail, Van Beneden, Dumortier, Rösel, Schäffer, Linnæus, Müller, Risso, and other continental naturalists.

If *Plumatella repens* be identical with *P. nitida*, Leidy, (see below, p. 109,) we will have then, on the authority of Dr. Leidy, an American locality (Pennsylvania) to add to the above.

Plumatella repens is a very elegant Polyzoon; the orifices for the egress of the polypides terminate in short, free, tubular ramuli formed by the continuation of the cells, and placed at intervals along the main branches, generally singly, but sometimes in groups of two, three, or even more. The quantity of earthy matter deposited in the ectocyst is small, and this tunic is generally more pellucid than we find it in most other species of the genus; it varies, however, in this respect, according to age and locality of growth, and is for the most part of a brown, or tawny colour, except in the immediate vicinity of the orifices, where it always becomes colourless and transparent; through this transparent portion, the endocyst is visible, and may be here generally seen, dotted with minute, opaque, white spots.

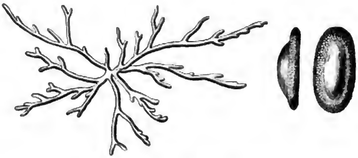
We should be careful not to lose sight of the existence of two distinct variations in this species, since a want of the proper recognition of their true significance has given rise, as we have already seen, to a mass of confusion in the synonyms of *P. repens*, such as, perhaps, can scarcely be paralleled in the literature of Zoology. In the first of these variations, (var. α,) which must be viewed as the normal and typical condition, the animal may be seen attaching itself to flat surfaces, as the under side of stones, and of the floating leaves of the water lily and other aquatic plants. In this condition it is closely adherent throughout its entire length to the surface on which it is developed, and forms elegant dendritic, or confervoid growths, radiating from a common centre. In the second, (var. β,) it will be found fixed to surfaces of small extent, as thin submerged stems, straws, &c., and as it continues to increase in size, the branches having no extensive surface of attachment, soon become free, and a more or less entangled bushy mass will be produced. These two variations are quite accidental, and altogether the result of external agencies influencing the growth of the species; indeed, the very same specimen will often exhibit both at the same time, continuing closely adherent to the stone or other object to which it happens to be attached, as long as this affords it sufficient surface for adhesion, but becoming free, and assuming the form of the second variation as soon as, in the progress of extension, it arrives at the margin of the sustaining body.

In some specimens of *P. repens* the cells are short, and the orifices, consequently approximated to one another, are placed at slight intervals along the branches, and give a sort of moniliform appearance to the cœnœcium; in others, again, the cells are long, and the orifices distant, and this condition chiefly occurs in the free variation where, the elongation of the cells not being restrained by adherence to a fixed surface, the orifices become widely separated from one another, and the moniliform character, so marked in the former condition, is nearly lost. It is in the latter form that the transverse septa are most apparent, indeed, I have met with specimens of the free variation of this species in which well-formed septa occurred between almost every cell, while the elongated claviform figure of the cells increased the resemblance to *Paludicella*, and even rendered the specimen liable, at first sight, to be mistaken for a large form of the latter Polyzoon.

P. repens is a light-shunning animal, and will be found only on the under side of stones, or in such other situations as are not exposed to the direct influence of daylight. The polypides are timid, generally withdrawing on the least disturbance, and not again venturing to display themselves till all is once more perfectly quiet. It often acquires a considerable size. I have met with luxuriant specimens of the adherent variation radiating over a space of upwards of twelve square inches on the surface of a flat stone, and specimens of the free variation have occurred to me with the branches more than three inches in length. In Ireland, *P. repens* is the most abundant and widely distributed of the fresh-water Polyzoa. It occurs in greatest perfection during summer and autumn.

2. *Plumatella stricta*, Allman.

Fig. 14.*



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* Figure copied from Van Beneden.

Specific character.—Cœnœcium adherent, creeping; cells cylindrical, narrow, destitute of furrow and keel. Statoblasts elongated.

SYNONYM.—1848. *Plumatella repens.* Van Beneden, Recherches sur les Bryoz., fluv. de Belg. p. 21, pl. 1, figs. 1—4, Mém. de l'Acad. Roy. de Belg., 1848. (Original figures.)

Iconography.—Original figures of Van Beneden.

HABITAT.—Stagnant waters? adhering to submerged surfaces.

LOCALITIES.—*British:* None.
Foreign: Brussels and Louvain. *Van Beneden.*

The present species has been formed for the *Plumatella repens,* Van Beneden, which, as has already been said, cannot be referred to the original *Tubularia repens* of Müller, the animal which all naturalists must now take as the model for the identification of the true *Plumatella repens.*

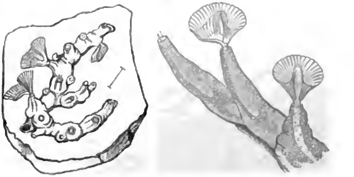
The narrow, cylindrical tubes and elongated statoblasts of *P. stricta* approach it to *P. emarginata,* from which, however, it is separated by the absence of a furrow.

"We have never," says M. Van Beneden, in his account of this species, "seen the polypary assume that fungoid aspect which is peculiar to the adult *Alcyonella.* The tubes remain always separated and even considerably elongated from one another. The parent branches lie prostrate upon the surface of the leaves to which they are attache d, but new buds often rise from them at a right angle.

"The polypary has often a yellow tint; its walls are less opaque than in the other species" (*P. campanulata,* Van Ben.)

3. *Plumatella punctata,* Hancock

Fig. 15.*



* Figure copied from Hancock.

Specific character.—Cœnœcium adherent, creeping, irregularly branched, branches composed of a series of large conical cells, tapering towards the orifice, destitute of furrow; the upper portion of the cell almost colourless and freckled with minute, opaque, white spots. Tentacula about sixty; calyx distinctly festooned. Statoblasts broad.

SYNONYM.—*Plumatella punctata.* Hancock, Ann. Nat. Hist., 2d series, vol. v, p. 200, pl. v, figs. 6, 7, and pl. iii, fig. 1.

Iconography.—Original figures of Hancock.

HABITAT.—Adhering to the under side of stones in lakes.

LOCALITY.—Bromley and Crag Loughs, Northumberland. *Hancock.*

The following is Mr. Hancock's description of this species:

"Polypidom adhering throughout, coriaceous, pellucid, of a pale, watery, green colour, irregularly but not much branched, seldom extending more than half an inch; branches composed of a series of large, conical cells, tapering upwards towards the aperture, sometimes considerably and rather suddenly dilated at the base, resembling in form some of the Ascidians; the upper portion of the cell almost colourless, and freckled with minute, opaque, white spots, most crowded towards the orifice. Tentacles white, not more than sixty in number; membrane at their origin rather wide, scalloped, the points of the scallop extending for some distance up the back of the tentacles in the form of broadish laminæ arched outwards. Œsophagus and stomach appearing through the transparent walls of the cell of a pale yellow colour. Egg perfectly black, large, broad, and oval.

"Upwards of a dozen specimens of this fine species occurred in Bromley Lough, adhering to the under side of stones; it was likewise taken in Crag Lough. None of the individuals much exceeded in size that represented in the figure, nor did they vary in any remarkable manner either in form or colour. It is not, however, without hesitation that I ventured to characterise this as a new species, as Professor Allman informs me that it may perhaps turn out to be *P. repens;* but that form is stated to be large and of luxuriant growth, and to have the polypidom tubular with the cells dilated at the orifice—characters which do not at all agree with *P. punctata*. Indeed it can scarcely be considered a true *Plumatella*."

I have never seen a specimen of *P. punctata*, but having read Mr. Hancock's detailed description I now agree with him in considering the species as a good one. Still, however, it comes very near to *P. repens*, closely resembling the young state of this species before the cœnœcium has acquired the more decidedly tubular condition of the adult.

4. *Plumatella vesicularis*, Leidy.

Specific character.—"Cœnœcium radiating and branched, attached, colourless, and transparent; each segment slightly dilated and much broader than the protuberant orifice of exit.

Length of the segments about 1 mm., breadth 1 mm. Animal colourless. Ova (statoblasts) oval, lenticular, with an annulus, but without spines." ***Leidy.***

SYNONYM.—1854. *Plumatella vesicularis.* Leidy, Proc. Acad. Nat. Sci. of Philadelphia, vol. vii, p. 192.

Iconography.—No published figure.

HABITAT.—On the under side of flat stones in running water.

LOCALITY.—Schuylkill River, Philadelphia. *Dr. Leidy.*

"This species of *Plumatella* is as limpid as the water in which it lives; and it resembles rows of colourless vesicles with a whitish line passing through their axis. Frequently it is observed with rows of imbricated blackish eggs instead of the latter line. Patches are found from a quarter of an inch to two inches square." *Leidy.*

All we know of the present species is from the above short description by Dr. Leidy. It seems to approach closely to *Plumatella punctata*, Hancock; and the absence of an authentic figure is here again much to be regretted.

5. *Plumatella fruticosa*, Allman. Pl. VI, figs. 3—5.

Specific character.—Cœnœcium irregularly branched, attached only at its origin; cells cylindrical, destitute of furrow, but obscurely keeled. Statoblasts elongated.

SYNONYMS.—1844. *Plumatella fruticosa.* Allman, Ann. Nat. Hist., vol. xii, p. 330.
1846. *Plumatella fruticosa.* Allman, Proc. Roy. Irish Acad., 1846.
1847. *Plumatella fruticosa.* Johnston, Brit. Zoophytes, 2d edit., p. 404.

Iconography.—No published figures.

HABITAT.—In lakes and ponds, and in rivers where the current is not too rapid, attached to the under and shady side of stones and to the stems and under side of the leaves of aquatic plants. Loving the shade.

LOCALITIES.—*British:* In the Regent Canal, London; the Chelmer Canal, Essex; Grand Canal, near Dublin; River Bandon; a small lake near Glandore; and in some other lakes and ponds in the county of Cork. *G. J. A.*

Foreign: Lake of Lucerne, and Lake Seculejo in the Pyrenees. *G. J. A.*

This species delights in still and slowly-running water, where it may be seen in the form of elegant little tree-like growths attached to stones and the stems of Potomogeton, Myriophyllum, and various other aquatic plants. It is easily distinguished from all the other species of *Plumatella*, except the free variation of *P. repens*, by its irregularly branched, bushy, non-adherent mode of growth: and from the latter it is at once known by its cylindrical branches and narrow statoblasts. In its general habit it bears a very close resemblance to *Fredericella*, indeed from a luxuriant specimen of the latter polyzoon it is frequently impossible to distinguish it without an inspection of the polypides or statoblasts.

I have found this species throughout the entire summer and autumn.

6. *Plumatella coralloides*, Allman. Pl. VII, figs. 1—4.

Specific character.—Cœnœcium attached only at its origin, and forming dense, erect tufts of dichotomously branched tubes, destitute of furrow and keel. Tentacula about sixty. *Statoblasts* broad.

SYNONYM.—1850. *Plumatella coralloides*. Allman, Brit. Assoc. Report, 1850.

Iconography.—No published figure.

HABITAT.—Attached to submerged bodies in still water. Avoiding the light.

LOCALITY.—The "London Docks" on the River Thames. *Mr. Bowerbank* and *G. J. A.*

This species rises to the height of from half an inch to an inch, in the form of dense tufts, consisting of tubes which repeatedly branch in a dichotomous manner as they extend upwards from the base. The branches are approximated, and are formed of a series of pellucid tubular cells, which are for the most part dilated upwards, and thus present a sort of claviform figure, while the ultimate ramuli, varying in length, bring all the orifices to the same level, and give to each tuft somewhat the appearance of certain varieties of that form of inflorescence known to botanists by the name of *cyme*. Almost every cell is separated from its neighbour by a very complete transverse septum. This septum is of a dark reddish-brown colour; and being visible through the pellucid walls of the cell, gives to the tubes the appearance of being divided at regular intervals into distinct joints. The cells are light yellowish-brown, of a membrano-corneous texture, and nearly free from earthy deposit.

P. coralloides presents in habit a very close resemblance to *Alcyonella fungosa;* indeed, it must be viewed as possessing an intimate relation with the latter Polyzoon; the already approximated branches need but advance one step further in their approximation, and by adhering to one another, give rise to a genuine *Alcyonella*, scarcely distinguishable from *A. fungosa*.

The present species occurred rather abundantly in the London Docks, on the River Thames; where, in company with Mr. Bowerbank, I met with it in July, 1849, attached to floating logs of wood, together with *P. repens* and *Cordylophora lacustris,* and generally immersed in masses of *Spongilla fluviatilis*.

7. *Plumatella emarginata*, Allman. Pl. VII, figs. 5—10.

Specific character.—Cœnœcium adherent, creeping; cells cylindrical, with a very distinct furrow, which gives an emarginate appearance to the orifices, and becomes continuous below, with a prominent keel. *Tentacula* about forty. (Free) *Statoblasts* elongated.

SYNONYMS.—1804. *Tubularia repens?* Vaucher, Bull. de la Soc. Philom., ann. xii, No. 81, pl. 19, figs. 1, 2, 3, 9, 10.
1816. *Plumatella repens?* Lamarck, An. sans Vert., 1st edit., vol. ii, p. 108.
1824. *Naisa repens?* Deslongchamps, Encyc. Méth., Zooph., p. 561.
1836. *Plumatella repens?* Lamarck, An. sans Vert., 2d edit., vol. ii, p. 123.
1844. *Plumatella emarginata.* Allman, Ann. Nat. Hist., vol. xii, p. 330.
1847. *Plumatella emarginata.* Johnston, Brit. Zooph., 2d edit., p. 404.

Iconography.—Possibly Vaucher's figures of his *Tubularia repens;* otherwise no published figure.

HABITAT.—In streams and rivulets, adhering to the under side of stones.

LOCALITIES.—*British:* In a beautiful little rivulet near Bandon, County of Cork. In the River Dodder, near Dublin, abundant. In a rivulet near Arklow, in the County of Wicklow, and in localities furnishing a similar habitat in other parts of Ireland. *G. J. A.*
Foreign: Lago di Como. *G. J. A.*—France? *Vaucher.*

The well-marked furrow in this species, commencing near the orifice in a transparent, triangular space, looking as if a piece had been cut out of the margin of the orifice, suggested the specific name, as this Polyzoon was, at the time of its discovery, the only species known with a similar condition of the ectocyst. Subsequent search, however, has brought to light several others with the same character; and though the name has thus lost its exclusive appropriateness, it has been nevertheless deemed convenient to retain it.

This Polyzoon is more opaque and coriaceous than *P. repens.* The ectocyst, except in the immediate vicinity of the orifices, and at the commencement of the furrow, is loaded with minute, irregularly angular, siliceous particles, giving it under the microscope the appearance of being in a great measure composed of agglutinated sand. It is of a ferruginous colour, becoming lighter towards the orifices, while the uniform diameter of the branches deprives it of the peculiar concatenated disposition which is generally so striking in *P. repens.* It is irregularly branched, adhering closely to the surface on which it grows, but frequently sending off several short free branches of about half an inch in length.

P. emarginata, unlike most of the other fresh-water Polyzoa, delights in rapid rivulets, though it also flourishes luxuriantly in the more quiet waters of lakes. It is eminently light-shunning; for though it loves the purest and clearest waters, it is always found on the under surface of stones, where scarcely a ray of even repeatedly reflected light can reach it. It occurs in greatest perfection during the summer and autumn; at the latter period the tubes are loaded with elongated ova, which lie quite loose within them, and are liberated on their rupture; besides these bodies, we find here also, as in *Alcyonella Benedeni*, ova of a broadly elliptical shape and imperfectly developed annulus; these last are always attached firmly to the walls of the tube. *P. emarginata* admits of an interesting comparison with *Alcyonella Benedeni*, to which it seems to be related exactly as *P. repens* is with *A. fungosa*.

8. *Plumatella diffusa*, Leidy.

Specific character.—Cœnœcium adherent, creeping; cells "keg-shaped" towards the orifices, which are rendered emarginate by a notch-like furrow continued down one side of the cell on a slight keel. Tentacula forty-two. Statoblasts elongated.

SYNONYM.—1851. *Plumatella diffusa.* Leidy, Proc. Acad. Nat. Sci. of Philadelphia, vol. v, p. 261.

Iconography.—No published figure.

HABITAT.—In running water, covering the under surface of submerged stones, and extending over spaces of from one to several square feet.

LOCALITIES.—Schuylkill and Delaware Rivers, Pennsylvania, and the brooks flowing into them. *Dr. Leidy.*

Dr. Leidy gives the following more detailed description of this species:

"Polypidom diverging from a centre over large surfaces, consisting of a series of simple curved branches, from one to two lines long, rising from one another upon the convex side, and attached throughout their length, except at the extremities, from $\frac{1}{4}$ to $\frac{1}{3}$ of a line, which are erect, keg-shaped, or a little dilated at the middle, and contracted at the orifices. Border of the orifices deeply emarginate, and continuous with a fissure down the inner or concave side of the branches upon the summit of a slight ridge. Colour dirty olivaceous brown, with the erect extremities of the branches yellowish or translucent whitish.

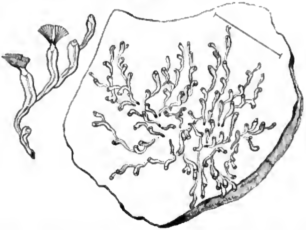
"Polypi with forty-two divergent sigmoid tentacula arranged at the summit in the outline of a reniform disc. Length of the tentacula about $\frac{1}{3}$ of a line; colour of stomach greenish-yellow.

"Ovum (statoblast) with its marginal sheath, semi-oval, $\frac{1}{55}$ of an inch long, $\frac{1}{100}$ of an inch broad. Sheath whitish, translucent, smooth, cellular; with the aperture on its convex side $\frac{1}{144}$ of an inch in diameter; that upon its flat side $\frac{1}{300}$ of an inch. Ovum (statoblast) lenticular, reddish-brown."

Plumatella diffusa comes certainly very close to *P. emarginata*, the slight dilatation of the cell just below the orifice being the only point in which I can find any valid distinction between the two species.

9. *Plumatella Allmani*, Hancock.

Fig. 16.*



Specific character.—Cœnœcium adherent, creeping; cells claviform, keeled. Tentacula forty-two; calyx distinctly festooned. Statoblasts elongated.

SYNONYM.—1850. *Plumatella Allmani.* Hancock, Ann. Nat. Hist., 2d series, vol. v, p. 200, pl. 5, figs. 3-5. (Original figures.)

Iconography.—Original figures by Hancock.

HABITAT.—Lakes, attached to the under side of stones.

LOCALITY.—Bromley Lough, Northumberland, rather abundant. *Hancock.*

I have not met with this Polyzoon. Mr. Hancock, who discovered it along with several other species in Bromley Lough, in the county of Northumberland, describes it as follows:

"Polypidom attached to the under side of stones, adhering throughout; membranous, opaque, yellowish-brown, slightly branched, extending in patches sometimes three or four inches wide, the patches being made up of several polypidoms; the branches composed apparently of a series of tubular cells, tapering to their origin, and attached for more than half their length; the enlarged extremity being free and bending upwards, inclines a little to one side, and is occasionally bifid, forming two cells; an obtuse ridge or keel extends the entire length of the cell, increasing imperceptibly in thickness upwards; orifice somewhat constricted, the walls immediately below being pellucid and suddenly dilating, become abruptly opaque and thickly covered for some distance downwards with agglutinated sand. Tentacles forty-two in number, slightly tinged with yellow, the colour best seen when they are formed into a compact bundle; membrane at their base distinct, scalloped, the point being prolonged a little up the tentacles. Egg (statoblast) black, long, oval; sides nearly parallel; margins pellucid, yellow, sharp, broad, and reticulated.

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* Figure copied from Hancock.

"This species was procured rather abundantly in Bromley Lough, and does not appear to vary much. At first sight, large patches of it have the appearance of being formed of a single polypidom; but on close examination are found to be composed of many, and rarely to number more than six or eight, cells in each. The commencement of each polypidom has the black envelope of the originating egg (statoblast) adherent."

Plumatella Allmani certainly comes very close to *P. emarginata* and *P. diffusa;* it is, however, distinguished from both by its cells being claviform, while they are cylindrical in *P. emarginata,* and keg-shaped towards the orifice in *P. diffusa.* Mr. Hancock describes the cœnœcium as keeled, but makes no allusion to the oblique or notch-like termination of the earthy deposit in the ectocyst, which is so distinct a character in *P. emarginata, P. diffusa,* and some other species; and yet from the very expressive figures of Mr. Hancock, I am inclined to believe in the existence of this character also in the present species.

10. *Plumatella elegans,* Allman. Pl. VIII, figs. 6—10.

Specific character.—Cœnœcium adherent, creeping, cells of uniform diameter; with a furrow and keel. Calyx but slightly festooned. Statoblasts broad.

SYNONYM.—1850. *Plumatella elegans.* Allman, British Association Report, 1850.

Iconography.—No published figure.

HABITAT.—On the under side of floating leaves in still water. Avoiding the light.

LOCALITY.—Millpond, Bandon Distillery, county of Cork, attached to the under surface of the leaves of *Potomogeton natans.*

I have as yet met with *P. elegans* only in one locality, and there it was by no means abundant. It occurred upon the under surface of the leaves of *Potomogeton natans* in small irregular patches, formed by a somewhat sinuous, branched, closely adherent tube. The ectocyst is brown, sabellose in its texture, and with a well-marked furrow, which passes below into a keel, and terminates near the orifice in a broad notch-like space. Transverse septa may be distinctly seen intersecting most of the cells near their origin. The polypides are small, and the calyciform membrane exhibits scarcely a trace of festooning. The statoblasts are elliptical, with a widely overlapping annulus; they are narrower than those of *P. repens,* but wider than the ova of *P. emarginata,* and present no tendency to the bean-shaped figure of the latter.

It was during the month of August that I met with this species.

11. *Plumatella Dumortieri,* Allman. Pl. VIII, figs. 1—5.

Specific character.—Cœnœcium adherent, irregularly branched; cells somewhat dilated towards the orifices, with a furrow carinated. Tentacula about fifty; festooning of calyx deep and distinct. Statoblasts broad.

SYNONYM.—1850. *Plumatella Dumortieri.* Allman, British Association Report.

Iconography.—No published figure.

HABITAT.—On submerged plants in still water.

LOCALITY.—In a pond at Crix, in the county of Essex, the property of Samuel Shaen, Esq. *G. J. A.*

This species has as yet been met with only in one locality, where, though I found several specimens, it was far from being abundant. It presented a small, irregularly branched cœnœcium, closely adherent to the submerged portions of *Potomogeton natans* and other aquatic plants. The ectocyst is yellowish-brown, becoming, as in all the furrowed species with which we are as yet acquainted, lighter coloured towards the extremity of the ramuli, and then assuming the thin transparent condition, which it retains as far as the orifice. This transparent portion is frequently dotted with minute brown points. The calyciform membrane of the polypide is nearly as deeply festooned as in *Fredericella*, and the statoblasts are broadly elliptical, resembling those of *P. repens.* I met with it in the month of July.

I have given to this species the name of M. Dumortier, a naturalist to whom we are indebted for some of the most valuable information we possess on the fresh-water Polyzoa.

11. *Plumatella jugalis,* Allman. Pl. VI, figs. 1, 2.

Specific character.—Cœnœcium adherent, consisting of two series of branches connected by a common tube, and extending in opposite directions; cells of uniform diameter, with a furrow which passes below into a keel. Tentacula about forty; calyx with shallow festoons. Statoblasts not known.

SYNONYM.—1850. *Plumatella jugalis.* Allman, British Association Report.

Iconography.—No published figure.

HABITAT.—On submerged plants in still water.

LOCALITY.—Canal near Little Baddow, Essex. *G. J. A.*

P. jugalis is a small species and occurs, rather abundantly in the sluggish waters of the Chelmer Canal, attached to the petioles and under surface of the leaves of *Nymphæa alba*. It is throughout closely adherent to the surface on which it grows, and is very remarkable by its mode of development in two distinct groups of branches, which are united to one another by a simple connecting tube, from which they extend in two opposite directions. The ectocyst is brown, becoming lighter towards the extremities of the branches, and finally extending as a delicate transparent and colourless membrane to the margin of the orifice; this transparent portion being, as in other furrowed species, withdrawn into the more opaque portion of the tube during extreme retraction. Most of the branches are intersected near their origin by very distinct septa, which are visible through the walls of the tube. I could find no statoblasts in any of the specimens I examined.

In its peculiar mode of development in two groups of tubes, *P. jugalis* presents a striking resemblance to *Alcyonella flabellum*; from the latter animal, however, it is at once distinguished by its narrow, widely diverging branches never contracting the slightest adhesion to one another.

I have as yet met with this species in but one locality, though its striking physiognomy could scarcely allow of its being overlooked.

The *Plumatella nitida*, Leidy ('Proc. Acad. Nat. Sci. of Philadelphia,' vol. v, p. 321), I cannot think entitled to rank as a distinct species. With the exception of the number of tentacula, which are described as being only forty-two, there is no character in which *P. nitida* does not entirely agree with *P. repens*, and this character by itself can scarcely be considered of sufficient importance to separate the two forms.

Genus VI. FREDERICELLA, *Gervais*, 1838.

Name.—In honour of Frederick Cuvier.

In 1774 Blumenbach gave the name of *Tubularia sultana* to a little fresh-water Polyzoon which he found in the neighbourhood of Göttingen, and which differed from all the then known fresh-water species in having the tentacula disposed in a circle instead of forming a crescent. This circular disposition of the tentacula, which at once distinguishes Blumenbach's animal from all the other fresh-water species except *Paludicella*, was properly considered by M. Gervais to be of sufficient importance to cause the *Tubularia sultana* to take the rank of a distinct genus, and he has accordingly assumed it as the type of his genus *Fredericella*.

Though the tentacular crown, however, may at first appear quite similar in its form to that of *Paludicella*, a careful examination will detect in the lophophore a deviation from the orbicular condition presented by this part in the latter, and the bi-laterality of the lophophore in *Fredericella* is still further maintained by the presence of the epistome, which is altogether absent in *Paludicella*. The epistome and calyciform membrane are, indeed, as well developed in *Fredericella* as in the species with crescentic lophophores, while *Paludicella*, the only genus with a truly orbicular lophophore, is also the only one in which the epistome and membrane are absent. The whole structure, moreover, of *Fredericella* is quite in accordance with that of the species with crescentic lophophores, and differs in many important particulars from the structure of *Paludicella*, so that notwithstanding the circular disposition of the tentacula the true affinities of the genus are with *Plumatella* rather than *Paludicella*

Generic character.—Cœnœcium confervoid, composed of a membrano-corneous branched tube, with the branches distinct from one another and terminated by the orifices. Lophophore nearly circular; tentacular crown campanulate. Statoblasts bean-shaped, destitute of annulus and spines.

Species unica.* *F. sultana*, Blumenbach. Pl. IX.

Specific character.—The same as that of the genus.

SYNONYMS.—1777. *Tubularia sultana.* Blumenbach, Handbuch der Naturgeschichte. (Original figure.)
1789. *Tubularia sultana.* Gmelin, Linn. Syst. Nat., p. 3835.

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* In my Synopsis of Fresh-water Zoophytes, published in the 'Annals of Natural History,' 1844, I have described as a distinct species, with the specific name *dilatata*, a *Fredericella* in which the branches become dilated towards the extremities; subsequent investigations, however, have led me to look upon the *F. dilatata* of that publication as a merely accidental variation of *F. sultana*, and the species must accordingly be suppressed.

1806. *Tubularia sultana.* Turton, Linn. Syst. Nat., vol. iv, p. 669.
1816. *Naisa sultana.* Lamouroux, Pol. flex., p. 224.
1828. *Plumatella gelatinosa.* Fleming, Brit. Anim.
1830. *Difflugia protæiformis.* Meyen, Isis, 1830, p. 187.
1834. *Difflugia protæiformis.* Meyen, Nov. Act. Acad. Cæs. Leop., vol. xvi, Suppl.
1836. *Plumatella sultana.* Dumortier, Mém. sur les Pol. comp. fluv., p. 22.
1838. *Plumatella sultana.* Johnston, Brit. Zooph., 1st edit., p. 323.
1838. *Fredericella sultana.* Gervais, Bull. Soc. Philomat.
1839. *Fredericella.* Van Beneden, Bull. Ac. Brux., tom. vi, 2^{de} partie, p. 277, fig. 2. (Original figure.)
1839. *Fredericella sultana.* Gervais, Ann. Franç. et Etrang. d'Anat., tom. iii, p. 136.
1840. *Fredericella sultana.* Gervais, Dict. Sci. Nat., Suppl., vol. i, Pl. Suppl., Pol. Fluv. (Original figures.)
1843. *Fredericella sultana.* Thompson, Rep. Brit. Assoc., p. 285.
1844. *Fredericella sultana.* }
1844. *Fredericella dilatata.* } Allman, Ann. Nat. Hist., vol. xiii, p. 331.
1844. *Fredericella sultana.* Allman, Proc. R. I. Acad., No. 44.
1847. *Fredericella sultana.* Johnston, Brit. Zooph., 2d edit., p. 405.
1848. *Fredericella sultana.* Van Beneden, Recherches sur les Bryoz. fluv. de Belg., p. 25, Mém. de l'Acad. Roy. de Belg.
1848. *Fredericella sultana.* Dumortier et Van Beneden, Hist. Nat. des Pol. Comp. d'eau douce, Mém. servant de Complément au tome xvi des Mém. de l'Acad. Roy. de Brux. (Original figures.)
1850. *Fredericella sultana.* Hancock, Ann. Nat. Hist., 2d series, vol. v, p. 173, pl. 2, figs. 1, 4, and 6, and pl. 3, fig. 1. (Original figures.)

Iconography.—The original figures are those of Blumenbach, Van Beneden (Bul. Ac. Brux.), Van Beneden (Mém. de l'Acad. Brux.), Gervais, and Hancock. There is also an original figure apparently referable to this species, though unaccompanied by a name, illustrating a paper by Mr. Varley in the 'Lond. Phys. Journal,' No. 2, 1844.

HABITAT.—On submerged stones and the stems and leaves of aquatic plants, in still water and moderately rapid rivulets. Preferring the shade.

LOCALITIES.—*British:* Generally distributed through England, Ireland, and Scotland; abundant in the Regent Canal, London; in the Grand Canal, Dublin; and in the Union Canal, Edinburgh. *G. J. A.*—Northumberland Lakes. *Mr. Hancock.*

Foreign: In a small lake called the Roth See, near the town of Lucerne; in Lago di Mezzola, Northern Italy; in the Canal du Midi, near Toulouse. *G. J. A.*—Germany. *Blumenbach.*—Near Paris. *Gervais.*—Belgium. *Dumortier* and *Van Beneden.*

F. sultana is one of the most widely distributed of the fresh-water Polyzoa; I have met with it abundantly in England, Scotland, and Ireland. It occurs in rather confused tufts attached to submerged plants, stones, &c. The cœnœcium is partly free, partly adherent, the adherent portion frequently extending over several inches, and sending off numerous free subdivided branches of an inch or more in height. The ectocyst is brown, membrano-corneous, opaque, with a slightly prominent keel running along each branch, but without any slit-like furrow. At the origin of the branches there is frequently found a more or less perfect septum. The tentacula are about twenty-four in number, constituting when the polypide is exserted a campanulate crown of great elegance.

The statoblasts are somewhat kidney-shaped or bean-shaped, with the annulus obsolete. They are small and seem to be but sparingly produced, a circumstance in which this animal differs strikingly from several species of *Alcyonella* and *Plumatella*, in which the tubes at the proper season are constantly found loaded with statoblasts in the greatest profusion.

The close resemblance of the bushy cœnœcium of this species to that of *Plumatella fruticosa* has been already mentioned, indeed I have no doubt of the one having been frequently mistaken for the other.

I have met with *F. sultana* during the whole of the spring, summer, and autumn months, both in standing water and rivers, generally avoiding direct exposure to the daylight, though not so decidedly a lover of obscurity as several other species of fresh-water Polyzoa. The tentacular plume is even to the naked eye an object of extreme elegance, and we can easily participate in the feelings which must have actuated Blumenbach when he bestowed on this little animal the imperial designation it has since borne. It can be kept alive and healthy in a phial of pure water, and when undisturbed the polypides will readily issue from their cells and display their plumy crowns. A large branch thus studded with the campanulate crests of the polypides is an object which in elegance can hardly be surpassed, and with these strange, sentient flowers instantly retreating on the approach of danger, and when all is once more quiet again coming forward in their beauty, presents a spectacle not easily forgotten.

PALUDICELLIDÆ.

Genus VIII. PALUDICELLA, *Gervais*, 1836.

Name.—A diminutive noun, formed from *palus*, standing water.

In the number of the 'Symbolæ Physicæ,' published in 1831, Ehrenberg described under the name of *Alcyonella articulata*, a fresh-water Polyzoon which he discovered in the neighbourhood of Berlin. M. Gervais shortly afterwards, having discovered near Paris an animal which agreed with Ehrenberg's description, saw the necessity of separating it from *Alcyonella* and placing it in a distinct genus, which he named *Paludicella*. About the same time Ehrenberg's animal was detected in the neighbourhood of Louvain by M. Van Beneden, and in Lough Erne, in Ireland, by Mr. William Thompson, of Belfast, who was thus the first to add this interesting Polyzoon to the Fauna of the British Isles.

Paludicella is one of the best marked of all the genera of fresh-water Polyzoa; its perfectly orbicular lophophore, with the absence of epistome and calyx, and its strikingly articulated cœnœcium, formed of regular claviform cells, all separated from one another by complete septa, together with several peculiarities in its internal structure already described, remove it by a well-marked interval from the other genera of the present monograph, and approximate it to certain marine representations of the class. The genus consists as yet of but a single species.

Generic character.—Cœnœcium membrano-corneous, branched; branches composed of a series of claviform cells placed end to end and separated from one another by complete septa; orifices tubular, lateral, placed near the wide extremity of each cell. Lophophore orbicular, no epistome or calyx. Statoblasts not observed.

Species unica. *Paludicella Ehrenbergi*, Van Beneden. Pl. X.

Specific character.—The same as those of the genus.

SYNONYMS.—1831. ***Alcyonella articulata.*** Ehrenberg, Symb. Phys. Evert., Dec. 1, Pol., fol. *a*.
1832. ***Alcyonella diaphana.*** Nordmann, Mikrograph. Beiträge, vol. ii., p. 75.
1836. ***Paludicella articulata.*** Gervais, Comptes Rend.
1837. ***Paludicella.*** Gervais, Ann. Sc. Nat., 2d series, tom. vii, p. 80.
1839. ***Paludicella articulata.*** Gervais, Ann. Franç. et Etrang. d'Anat., tom. iii, p. 75.
1839. ***Paludicella.*** Van Beneden, Bull. Ac. Brux., tom. vi, 2d part, p. 278, fig. 1. (Original figure.)
1840. ***Paludicelle articulée.*** Gervais, Dict. Sc. Nat., Suppl., vol. i, pl. 1, Pol. Fluv., fig. 6. (Original figure.)
1842. ***Paludicella articulata.*** Allman, On the Muscular Syst. of Palud., &c., Roy. Irish Acad., No. 38, with a plate. (Original figure.)

1843. *Paludicella articulata.* Thompson, Rep. Brit. Assoc., p. 285.
1844. *Paludicella articulata.* Allmann, Ann. Nat. Hist., vol. xiii, p. 331.
1847. *Paludicella articulata.* Johnston, Brit. Zooph., 2d edit., p. 405, fig. 77, p. 406. (Original figure.)
1848. *Paludicella Ehrenbergi.* Van Beneden, Recherches sur les Bryoz. fluv. de Belg., p. 27, Mém. de l'Acad. Roy. de Belg.
1848. *Paludicella Ehrenbergi.* Dumortier et Van Beneden, Hist. Nat. des Pol. Comp. d'eau douce, Mém. servant de Complément au tome xvi des Mém. de l'Acad. Roy. de Brux. (Original figures.)
1850. *Paludicella procumbens?* Hancock, Ann. Nat. Hist., 2d series, vol. v, p. 201, pl. 5, figs. 1, 2, and pl. 4. (Original figures.)
1851. *Paludicella elongata?* Leidy, Proc. Acad. Nat. Sci. of Philadelphia, vol. v, p. 321. (Original figure.)

Iconography.—The original figures are those of Van Beneden (Bul. Ac. Brux.), Van Beneden (Mém. de l'Ac. Brux.), Gervais, Allman, Johnston, Hancock, and Leidy.

HABITAT.—On submerged stones in still and slowly running water. Eminently light-shunning.

LOCALITIES.—*British:* Regent Canal, London; Chelmer Canal, Essex; Grand Canal, Dublin; Union Canal, Edinburgh. *G. J. A.*—Lough Erne, Ireland. *Mr. Wm. Thompson.*—Bromley Lough, Northumberland. *Mr. Hancock.*

Foreign: Lake of Lucerne, Lake of Zurich, Lago di Como, and Lago di Lugano. *G. J. A.*—Near Paris. *Gervais.*—Belgium. *Dumortier* and *Van Beneden.*—Prussia. *Ehrenberg.*—Near West Point, in the United States; abundant. *Prof. Bailey.*

The specific name *articulata*, originally applied to this species by Ehrenberg, was sufficiently significant, so long as the animal was described as a species of *Alcyonella;* it is now, however, quite inapplicable, for it possesses no specific meaning whatever, being expressive of one of the most striking characters on which the *genus* formed for it has been founded. I, therefore, entirely agree with M. Van Beneden, in admitting the necessity of changing the original specific name, and willingly adopt that of *Ehrenbergi*, proposed for it by the learned Belgian naturalist in honour of its discoverer.

P. Ehrenbergi is very widely distributed, and we can scarcely account for its having so long escaped notice, except by supposing that its resemblance to some of the confervoid algæ caused it to be overlooked. The cœnœcium is partly free, partly adherent. The adherent portion extends over the under surface of stones as a branched confervoid growth, the branches being given off either opposite to one another in pairs, or else singly, the development of the opposite branches being in the latter case suppressed. Besides the portion which thus continues closely adherent to the supporting surface, numerous branches remain quite free, growing in luxurious specimens frequently to the length of two inches, and being themselves ramified in a manner quite similar to what occurs in the adherent portion.

The structure of both adherent and free portion is similar, every branch consisting of a series of symmetrical clavate cells, each of which is attached by its narrow extremity to the wide extremity of the cell below it, from which its cavity is separated by a perfectly formed septum, visible through the transparent walls of the cell; the entire cœnœcium thus presents a very striking and elegant concatenated appearance. The orifices are unilateral, and are placed at the extremity of little tubes, which project obliquely forward from the side of the cell near its wide end. The branches are given off at nearly right angles from the wide part of the cell, one at each side of the tubular orifice, and are thus (unless when the suppression of one of them takes place) situated in pairs one opposite to the other, with the tubular orifice between them.

The ectocyst is a pellucid membrano-corneous tunic, nearly colourless in young specimens, but acquiring a dark brown colour by age.

The polypide has but sixteen tentacula, springing from the margin of the orbicular lophophore, in a perfectly infundibulate crown.

Van Beneden* describes the occurrence of what he terms "hybernacula," in *Paludicella Ehrenbergi*. These hybernacula are gemmæ, which, under the influence of a favorable temperature, would have grown into the ordinary lateral branches of the Polyzoon, but which towards the commencement of winter acquire a conical form, and then become for a while arrested in their development. In this state, surrounded by a firm membrane of a blackish-gray colour, they continue until the following spring, when the investing membrane splits to allow of the elongation of the branch. In no instance have I witnessed the hybernacula in the specimens of *Paludicella* collected in Britain.

P. Ehrenbergi is an exceedingly timid little animal, and a specimen may be for hours under observation before the polypides will venture to issue from their cells, and then it is often for only a few seconds at a time, that they will continue visible. It is eminently a lover of obscurity, being only found in such situations as are not exposed to the direct influence of daylight; the most luxuriant specimens I have met occurred under the arches of viaducts on the Grand Canal, near Dublin; and in similar situations elsewhere, where the constant obscurity in which they live is never interrupted by a single ray of direct daylight.

The species occur all through the year in still and slowly running water, but is most abundant during the summer and autumn.

After a careful consideration of the animal described by Mr. Hancock† under the name of *P. procumbens*, I have been unable to agree with this naturalist in considering it a distinct species. The main character on which Mr. Hancock relies, is the supposed smaller number of tentacula in his species, a belief to which he was naturally lead in consequence of the figure of *P. Ehrenbergi* given by me in the 'Proceedings of the Royal Irish Academy, 1843,' having been erroneously engraved with twenty-six tentacula. Mr. Hancock also relies on the less densely and luxuriantly branched condition of his specimens, and on a smaller size and difference of colour in the cells, as grounds for distinction, but I believe these to be characters depending solely on age and accidental circumstances of growth. I cannot think, therefore, that there are sufficient reasons for considering the *P. procumbens* of Hancock as distinct from *P. Ehrenbergi*.

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* Dumortier and Van Beneden, 'Hist. Nat. des Pol. Com. d'eau douce, Mém. servant de Complément au tome xvi des Mém. de l'Acad. Roy. Bruxelles.'

† Hancock, in 'Ann. Nat. Hist.,' 2d series, vol. v, p. 201.

I have also been unable to find, in the characters assigned by Dr. Leidy* to the species occurring in the neighbourhood of Philadelphia, and named by him *Paludicella elongata*, sufficient grounds for the separation of the American form as a distinct species from the European one. A slight difference in the length of the cells cannot afford a valid specific difference, and this view is fully borne out by the figure which accompanies Dr. Leidy's paper.

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* Leidy, in 'Proc. Acad. Nat. Sci. of Philadelphia,' vol. v, p. 321.

URNATELLIDÆ.

Genus VII. URNATELLA, *Leidy*, 1851.

Name.—A diminutive noun, formed from *urna*, an urn, in allusion to the urn-shaped figure of the articulations.

We find, in the fifth volume of the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' a new Polyzoon described by Dr. Leidy under the name of *Urnatella gracilis*. It resembles, as Dr. Leidy informs us, a miniature *Isis hippuris*, and was discovered growing upon the under side of stones, in the River Schuylkill, near Philadelphia. Dr. Leidy accompanies his communication with a figure of the cœnœcium; and though he had not succeeded in detecting the polypides, he felt himself justified in viewing the production in question as a true Polyzoon.

At a subsequent meeting of the Academy ('Proc. Acad. Nat. Sc. of Philadelphia,' vol. vii. p. 191), Dr. Leidy again offers some remarks on *Urnatella gracilis*. Since his previous communication, he had detected the polypides, and had also in other respects succeeded in making a more satisfactory examination of the new Polyzoon, so that he now finds it necessary to alter in some points his previous description.

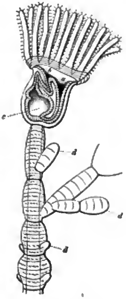
His account is confined to a generic and specific diagnosis, from which it appears that *Urnatella gracilis* is a most remarkable animal, and one of the most beautiful of the freshwater Polyzoa. The following are the characters given by Leidy in his amended diagnosis:

Generic character.—"Cœnœcium consisting of a series of segments up to eighteen in number, and forming free semi-erect curved stems, attached only by the base of the lowest segment. Segments, excepting the three last ones, simple, urniform; the antepenultimate and the penultimate oblong, with simple or compound branches of the same form; the last segment or active polyp is campanulate, and is supplied with cylindrical ciliated arms, arranged in a circle round the mouth." *Leidy.*

Species unica. *Urnatella gracilis*, Leidy.

Specific character.—"Stems single or in groups up to six in number, attached at the lower extremity by means of a sienna-coloured granular substance. Urniform segments 225 mm. long by ·18 mm. broad, becoming smaller towards the free end of the stems; body portion of each urniform segment translucent, whitish, with sienna-coloured transverse striæ and punctæ, and having on each side near the bottom a roundish process, the remains of former branches; the narrow top and bottom portion of the segments brown in colour and annulated. The antepenultimate and penultimate segments and their branches oblong, translucent. Polyp. ·225 to ·45 mm. long, campanulate; expanded, mouth circular, the diameter equal to the length of the body, surrounded by fourteen cylindrical, ciliated, retractile arms. Stems up to 4 mm. in length." *Leidy.*

Fig. 17.*



Urnatella gracilis.

a. Oral orifice. *b*. Anal orifice. *c*. Stomach. *d d d*. Gemmæ.

Synonyms.—1854. *Urnatella gracilis.* Leidy, Proceedings Acad. Nat. Sci. of Philadelphia, vol. v, p. 321. (Original figure of the cœnœcium.)
1854. *Urnatella gracilis.* Leidy, Proceedings Acad. Nat. Sci. of Philadelphia, vol. vii, p. 191.

Iconography.—Original figures of the cœnœcium by Leidy.

Habitat.—On the under side of stones in running water.

Locality.—River Schuylkill, in the city of Philadelphia, United States. *Dr. Leidy.*

Besides the two short notices contained in the references given above, there is no other published account of this remarkable genus, and zoologists cannot but look forward with impatience to the fuller description promised by its discoverer.

While the present sheets were passing through the press, I received a note from Professor Leidy, along with a pencil sketch of the expanded polypide, from which I have given the accompanying woodcut. "The anatomy of the animal," writes Dr. Leidy, "is easily examined, but in numerous specimens I have been unable to detect the slightest trace of generative structures; while on the other hand, the stomach is almost constantly more or less filled with large leucophroid bodies, which I am inclined to suspect are the reproductive bodies."

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* From a pencil sketch furnished by Dr. Leidy.

The annexed figure of *Urnatella* is so strongly suggestive of the marine genus *Pedicellina* that I feel much tempted to place *Urnatella* in the sub-order *Pedicellinea*, in which it would then become the type of a distinct family in this sub-order. With our present imperfect knowledge of its anatomy, however, such an association would hardly be justified, and I have therefore deemed it most advisable to view it for the present as the type of a sub-order of gymnolæmatous Polyzoa, premising at the same time that this location is to be considered as purely provisional.

The following Letters apply in all the Plates where they are used to corresponding parts of the structure:

a. Endocyst.
b. Ectocyst.
b'. Septum of *Paludicella*.
c. Invaginated portion of the endocyst.
c'. The proper tentacular sheath.
d. Mouth.
e. Epistome.
e'. Orifice in lophophore forming a communication between the cavity of the epistome and the perigastric space.
f. Œsophagus.
f'. Cardia.
g. Cardiac cavity of stomach.
g'. Pyloric cavity of stomach.
h. Intestine.
h'. Pylorus.
i. Anus.
k. Lophophore.
l. Tentacula.
m. Calyx.
n. Retractor muscles of polypide.
o. Accessory fibres of retractor.
p. Rotatory muscles of tentacular crown.
q. Tentacular muscles?
r. Elevator muscle of epistome.
s. Anterior parieto-vaginal muscles.
t. Posterior parieto-vaginal muscles.
v. Parietal muscles.
w. Nervous ganglion.
x. Nervous filament to lophophore.
x'. Nervous filament passing round the lophophore
y. Nervous filament to œsophagus.
z. Statoblast.
θ. Funiculus.
θ'. Superior funiculus of *Paludicella*.
κ. Hepatic layer of stomach.
λ. Middle layer of stomach.
λ^1. Internal layer of œsophagus.
λ^2. Internal layer of rectum.
μ. External layer of stomach.
μ^1. External layer of œsophagus.
μ^2. External layer of rectum.
ξ. Spermatozoa.
ϕ. Gemma.
χ. Testis.
ψ. Ovary.

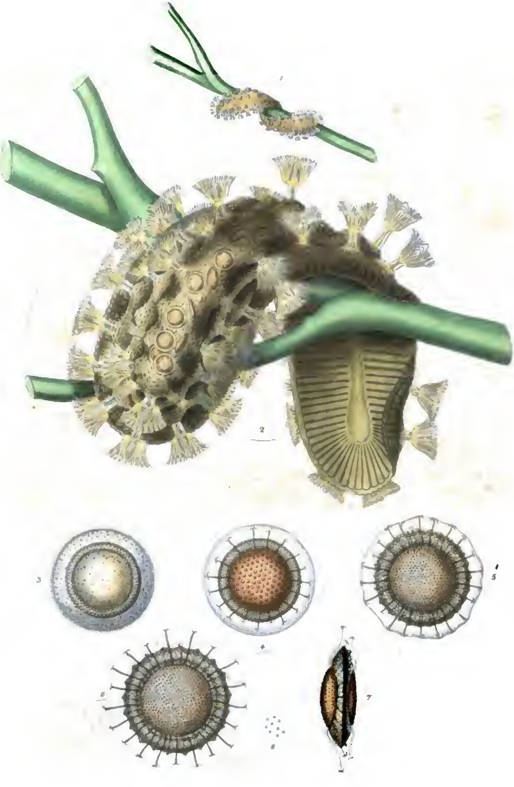
DESCRIPTION OF THE PLATES.

PLATE I.

CRISTATELLA MUCEDO.

Fig.

1. *Cristatella mucedo;* an adult specimen, adhering to the submerged stem of *Ranunculus aquatilis.* Of the natural size.
2. The same enlarged.
3. Statoblast of *Cristatella mucedo* in an early stage; it is surrounded by a ciliated membrane, and there is as yet no appearance of the marginal spines.
4. The same more advanced; the enveloping membrane is destitute of cilia, and the spines have begun to grow out from the margin of the disc.
5. The same, still further advanced; the spines have impinged on the enveloping membrane.
6. The mature statoblast; the enveloping membrane has been torn by the pressure of the spines, and has disappeared, and the statoblast has become free.
7. The same, viewed on the edge. Figs. 3—7 are magnified about 50 diameters.
8. Natural size of mature statoblast.



CRISTATELLA MUCEDO

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PLATE II.

LOPHOPUS CRYSTALLINUS.

Fig.

1. *Lophopus crystallinus;* specimens attached to the roots of *Lemna polyrhiza.* Natural size.
2. The same enlarged; adult specimen.
3. The same; young specimen, with two polypides.
4. Statoblast of *Lophopus crystallinus*, magnified about 50 diameters; viewed in face.
5. The same, viewed on the edge.
6. Portion of internal or hepatic layer of stomach.
7. Three isolated cells of this layer further magnified. Each cell is seen to contain within it a secondary cell, with brown contents.
8. Middle layer of stomach, composed of cells with colourless contents, and brilliant nucleus.
9. Structure of the endocyst; the tissue has been treated with acetic acid, and presents isolated nuclei, and nucleated cells in various stages of formation.
10. Muscular network of the endocyst.
11. Muscular fibre from the endocyst more highly magnified, and treated with acetic acid.
12. An isolated muscle-cell of the same, still more highly magnified.
13. Tubular network, containing peculiar corpuscles, occasionally seen in the substance of the endocyst.
14. Corpuscles of the tubular network isolated.
15. The same, under the action of acetic acid.

16—23. Parasitical organisms from the perigastric fluid of *Lophopus crystallinus.*

24. Semi-ideal view of part of the lophophore and tentacular crown of *Lophopus*, showing the mouth and neighbouring parts, with the distribution of the nerves. The tentacula are partially removed, so as to bring into view the upper surface of the lophophore.

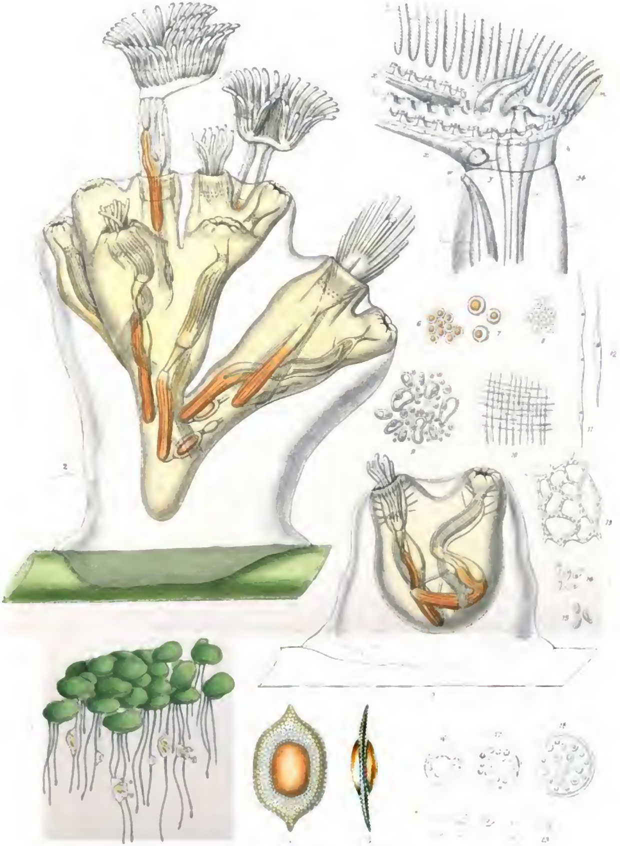
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PLATE III.

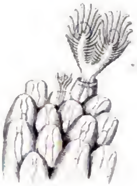
ALCYONELLA FUNGOSA.

Fig.

1. A specimen of *Alcyonella fungosa*, represented of the natural size, as developed round a twig.
2. A portion of the surface magnified, with a polypide protruded; it is viewed obliquely, so as to show the papilliform termination of the cells.
3. The same, viewed perpendicularly; the polypides are all retracted, and the papilliform terminations of the cells foreshortened in the view.
4. A portion of the dead cœnœcium magnified, and seen in vertical section; the cells towards the bottom are seen to be loaded with statoblasts.

5, 6 Statoblast, magnified about 60 diameters.

7. Longitudinal section through polypide and cell, showing anatomical details.



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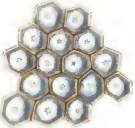

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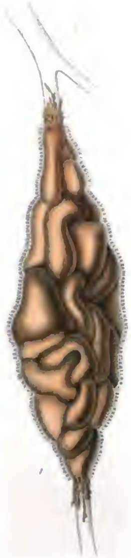

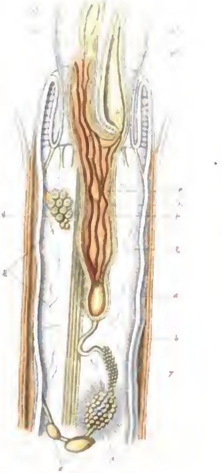

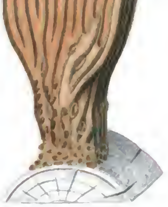

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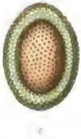

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PLATE IV.

ALCYONELLA FLABELLUM and ALCYONELLA BENEDENI.

Fig.

1. *Alcyonella flabellum.* Natural size.
2. The same magnified.
3. A young specimen of the same magnified, with the two valves of the statoblast still adhering to it.
4. Longitudinal section of upper part of the cell of *A. flabellum*, showing certain anatomical details.
5. *Alcyonella Benedeni;* a portion of a specimen. It is drawn of the natural size.
6. A portion of the same magnified.
7. Free statoblast of *A. Benedeni;* more convex face.
8. The same; less convex face.
9. The same, viewed on the edge.
10. Adherent statoblast of *A. Benedeni;* it is surrounded by a portion of the unorganized cement, by which it adheres to the walls of the cell.
11. Young specimen of *A. Benedeni,* with the separated valves of the statoblast still attached to it.

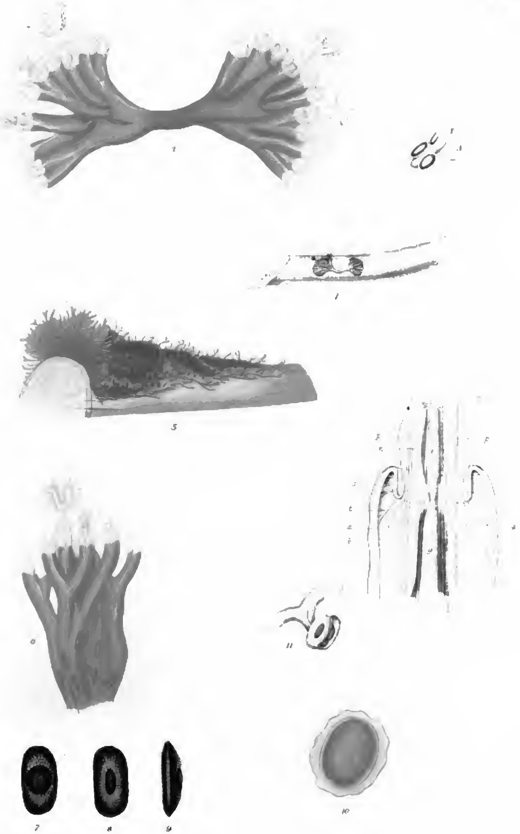
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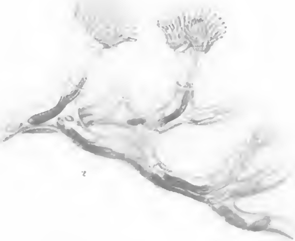
PLATE V.

PLUMATELLA REPENS.

Fig.

1. *Plumatella repens*, var. *a*, creeping over the surface of a stone. Natural size.
2. Portion of the same magnified.
3. *Plumatella repens*, var. *β*, growing on a portion of a submerged stem. Natural size.
4. Portion of the same magnified.
5. A cell of *P. repens*, with the polypide exserted; very much enlarged, to show anatomical details.
6. Extremity of the cell, with the polypide retracted.
7. Statoblast, viewed on the face.
8. The same, viewed on the edge, and seen in section.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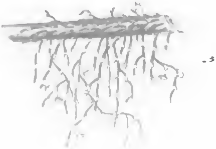
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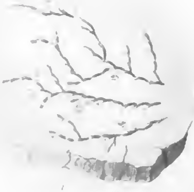

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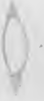
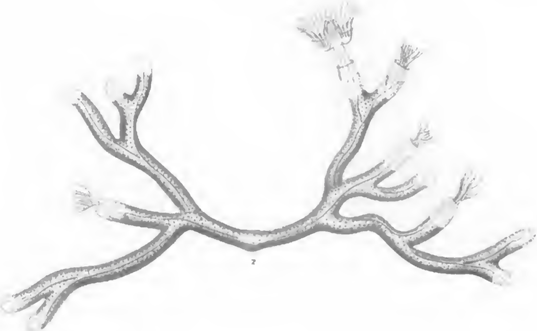


PLATE VI.

PLUMATELLA JUGALIS and PLUMATELLA FRUTICOSA.

Fig.

1. *Plumatella jugalis*, attached to the under surface of a floating leaf of *Sagittaria sagittifolia*. Natural size.
2. The same magnified.
3. *Plumatella fruticosa*, attached to the petiole of *Sagittaria*. Natural size.
4. Portion of the same magnified.
5. Statoblast of *P. fruticosa*.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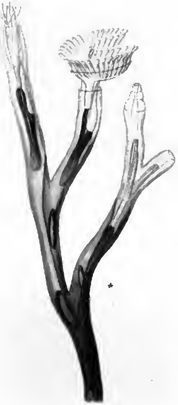
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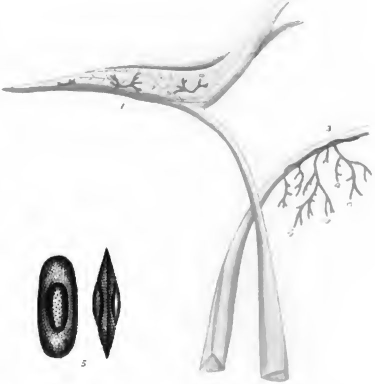
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PLATE VII.

PLUMATELLA CORALLOIDES and PLUMATELLA EMARGINATA.

Fig.

1. *Plumatella coralloides*, growing upon a piece of submerged timber. Natural size.
2. Portion of the same magnified.
3. Base of a branch of *P. coralloides*, with an imperfect septum.
4. Statoblast of *P. coralloides*.
5. *Plumatella emarginata*, creeping over the surface of a submerged stone. Natural size. Some of the statoblasts are seen adhering, in rows, to the stone.
6. Portion of the same magnified.

7, 8. Free statoblast of *P. emarginata*.

9. Adherent statoblast of the same.
10. A row of adherent statoblasts, with the unorganized cement which attaches them to the walls of the cell.

PLUMATELLA

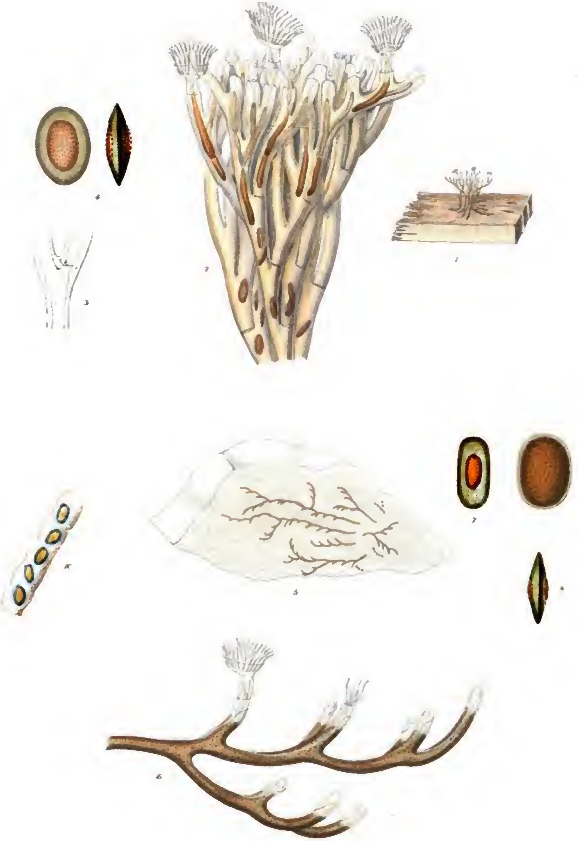

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PLATE VIII

PLUMATELLA DUMORTIERI and PLUMATELLA ELEGANS.

Fig.

1. *Plumatella Dumortieri*, attached to a submerged stem. Natural size.
2. Portion of the same magnified.
3. End of a branch, with the polypide retracted, still further magnified, to show the transparent furrow in the ectocyst, with its notch-like extremity.
4. Portion of the calyx of the same, much magnified, to show its festooned margin.
5. Statoblast of the same.
6. *Plumatella elegans*, attached to the under surface of a leaf of *Potamogeton*. Natural size.
7. Portion of the same magnified.
8. Portion of the calyx of the same, much magnified, to show its nearly even margin.
9. Statoblast of the same.

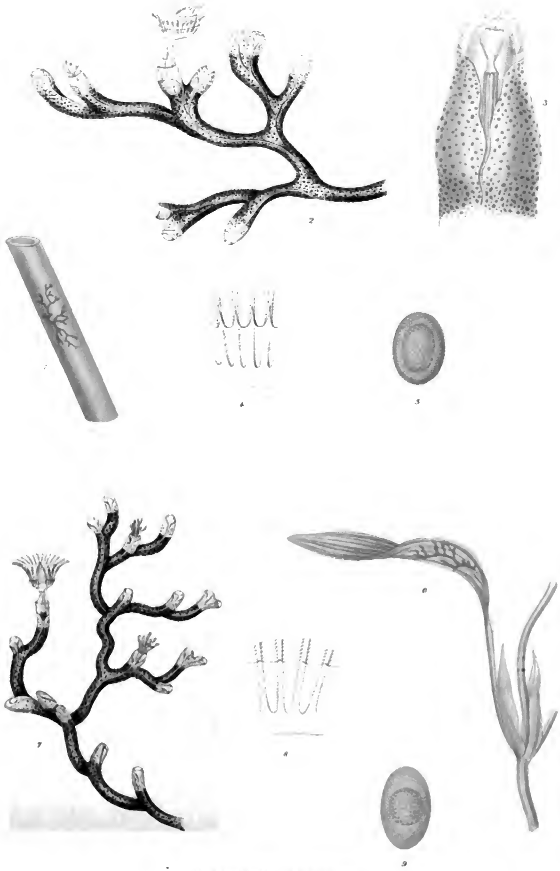
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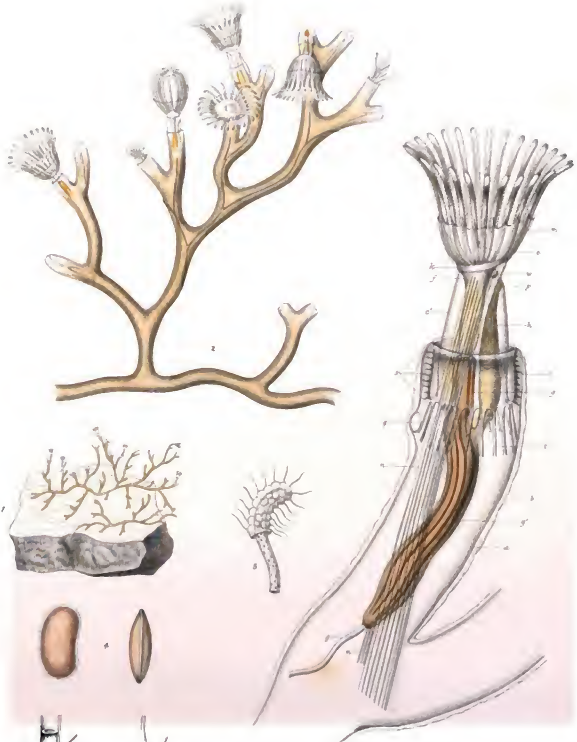
PLATE IX.

FREDERICELLA SULTANA.

Fig.
1. *Fredericella sultana*, attached to a stone. Natural size.
2. Portion of the same magnified.
3. Imperfect septum at commencement of a branch.
4. Statoblast.
5. Extremity of a tentacle, much magnified, with the internal layer partly exposed by the removal of the external cellular layer.
6. Muscular fibre of *F. sultana*, showing its striated structure, and its tendency to break into discs. The central fibre of the group is seen to be irregularly swollen, as it appears when in a state of contraction.
7. A very much enlarged drawing of the polypide and cell, to show anatomical details.

FREDERICELLA.



F. SULTANA.

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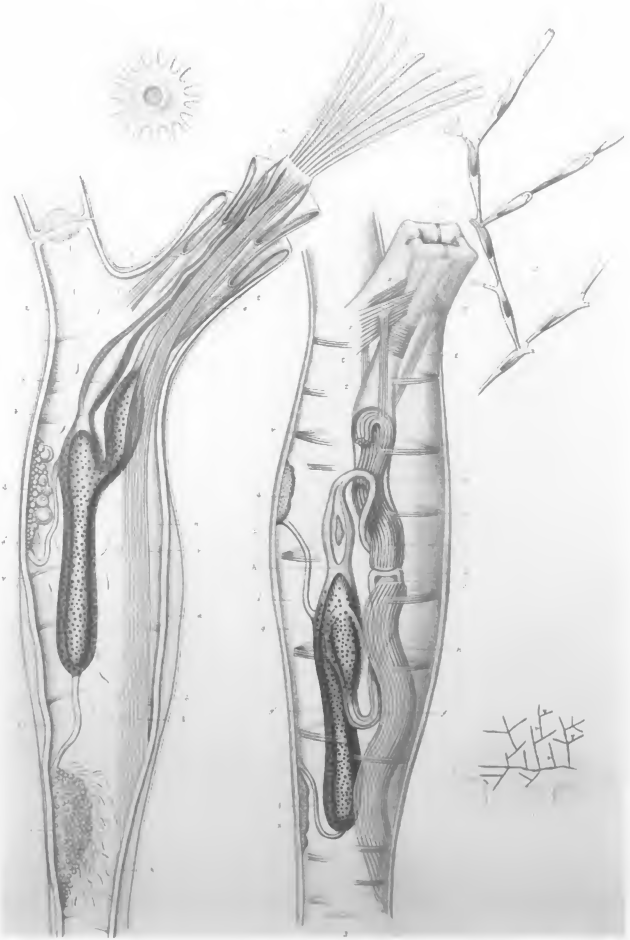
PLATE X.

PALUDICELLA EHRENBERGI.

Fig.

1. *Paludicella Ehrenbergi*, attached to a submerged stone. Natural size.
2. A portion of the same magnified.
3. A very much enlarged drawing of a cell with the polypide retracted; showing the anatomical details.
4. A cell seen in section with the polypide exserted, and exhibiting anatomical details. The ovary and testis are here fully developed, while in fig. 3 they are represented in an undeveloped state.
5. Lophophore viewed upon the upper surface, with the mouth, and roots of the tentacula.



PALUDICELLA EHRENBERGII.

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PLATE XI.

DEVELOPMENT OF GEMMA AND OVUM.

Fig.

1—9. Successive stages of the development of the gemma in *Paludicella Ehrenbergi*.

10—16. Successive stages of the development of the gemma in *Lophopus crystallinus*.

17. Cell from the testicle of *Alcyonella fungosa* filled with secondary nucleated cells ("vesicles of evolution").

18. The mother-cell has disappeared, but the vesicles of evolution still adhere together, while from several the spermatozoal filament is seen projecting.

19. A mother-cell containing vesicles of evolution; the spermatozoal filament has become partially liberated from several of the vesicles of evolution, and appears to perforate the walls of the mother-cell.

20. A vesicle of evolution more highly magnified. The original nucleus has become converted into a spermatozoal filament, which lies coiled up within the cell.

21. Spermatozoal filaments escaping from the vesicles of evolution.

22. A vesicle of evolution with the spermatozoal filament partly liberated, and presenting a spiral form.

23. Spermatozoa of *Alcyonella fungosa* as they appear when floating freely in the fluid of the perigastric space.

24. Mother-cells containing nucleated vesicles of evolution from the testis of *Paludicella Ehrenbergi*.

25. Free spermatozoa of *Paludicella Ehrenbergi*.

26. A group of ova from the ovary of *Alcyonella fungosa*.

27. A single ovum from the same, more highly magnified.

28. The ovum has undergone segmentation, and a central cavity has begun to show itself.

29. The embryo is here seen in the form of an oval ciliated sac, destitute as yet of external orifice.

30. The embryo now presents an orifice through which an unciliated portion is protruded by a process of evagination. In this protrusible portion a polypide is developed.

30^{a}. The polypide from the last isolated. The lophophore is as yet destitute of tentacles.

30^{b}. The same polypide slightly more advanced. Some tentacles have begun to develope themselves from the margin of the lophophore.

31. An embryo containing two polypides.

32. The same more advanced. The polypides have acquired nearly their perfect development.

33. The same, with the anterior part withdrawn into the posterior, as occurs when the embryo is in the act of swimming.

33^{a}. A group of embryos in this stage of their natural size.

33^{b}. A similar group more magnified, and in the act of swimming.

34. More advanced stage. The first invagination has become obliterated; the cilia have disappeared from the surface, and the young polyzoon has acquired its ectocystal

PLATE XI (*continued*).

Fig.

investment. A new bud is seen at each side within the cell, near its anterior extremity.

35. Embryo of *Plumatella fruticosa*.

36. Statoblast of *Lophopus crystallinus* in a very early stage, in which it appears as a minute swelling upon the funiculus.

37. The same more advanced. The contents of the statoblast are here seen to be divided into two distinct portions.

38. The same still further advanced. The division into two masses has disappeared, and the whole contents are surrounded by a distinctly cellular membrane.

39. The same after the appearance of the annulus, which as yet presents but a simply granular structure.

40. Peculiar cells from the annulus in a later stage of development.

41. The statoblast ruptured under compression, and the contents escaping in the form of minute cells.

41ᵃ. A group of cells constituting the contents of the statoblast, more highly magnified.

41ᵇ. Peculiar refractive corpuscles constituting the contents of these cells.

42. Statoblast of *Plumatella repens*, with the young polyzoon escaping from it. Its two faces have separated from one another, and are seen still adhering to the posterior part of the polyzoon which floats freely through the surrounding water. The polypide is here represented as exserted from its cell.

43. The same, with the polypide retracted.

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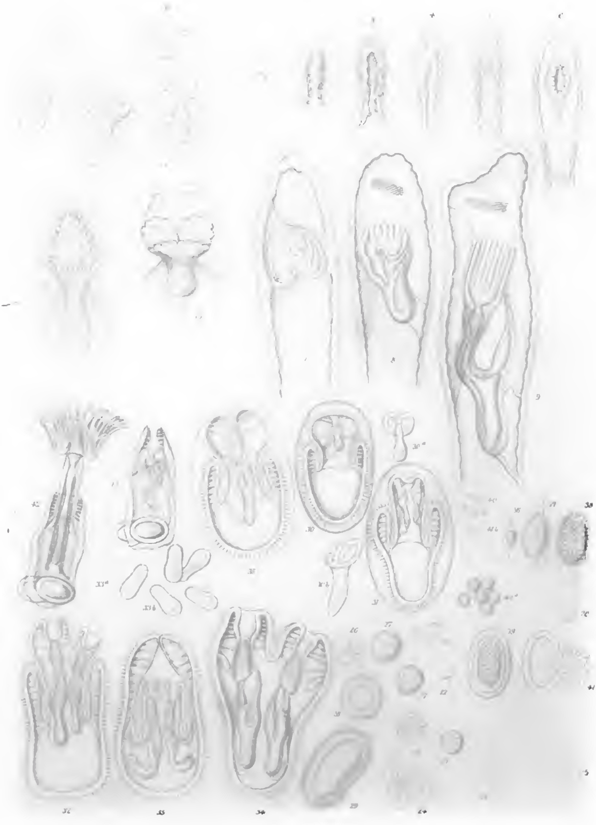
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